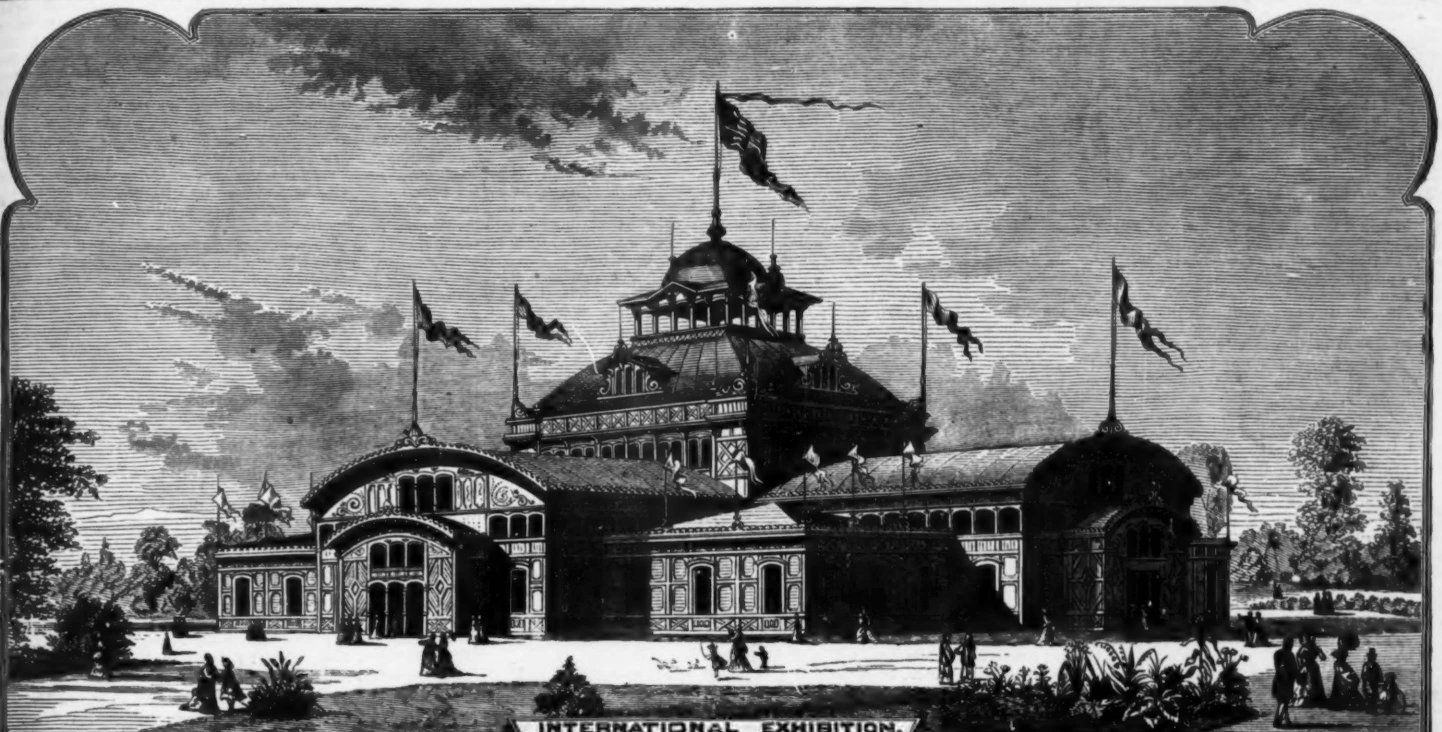
SCIENTIFIC AMERICAN SUPPLEMENT

Scientific American Supplement, Vol. I., No. 8.
Scientific American, established 1845.
New Series, Vol. XXXIV., No. 8.

NEW-YORK, FEBRUARY 19, 1876.

Scientific American Supplement, $5 a year.
Scientific American and Supplement, $7 a year.
Postage free to Subscribers.



1776. WOMEN'S PAVILION. 1876.

BUILDINGS OF THE CENTENNIAL EXHIBITION.

In continuance of our illustrations of the Centennial Buildings, we herewith present views of the Women's Pavilion and of the Judges' Pavilion, for which latter and the following description, we are indebted to *Frank Leslie's Newspaper*.

"Day by day, the Centennial Grounds are assuming the aspect of a city of magnificent buildings. The 230 acres set aside for the purpose of the Exhibition were a year ago a picture of rural beauty—a sylvan retreat, where one could wander beneath grand old trees, in thickets of brushwood and along pathways heavy with the scent of wood-flowers—a place where one could seek the charm that comes with the deep solitude of woods, and the rest and peace that green sods and fragrant boughs exhale. But busy man has changed the scene. Trees that waved their branches to the winds for a hundred years have been felled; walks and drives have been laid out where footpaths wound over hill and dale, and the whole aspect of the place has been altered. The ground is now dotted with magnificent structures. In addition to the principal buildings, which have already been fully described in these pages by pen and pencil, numerous other edifices, erected by foreign nations, our own States, and by representives of special interests and industries, adorn the grounds. Fully one hundred and fifty, and perhaps two hundred, buildings will be located in the inclosed space set aside for the great Exposition—all built with due regard for architectural display, and harmoniously blending with the artistically arranged grounds, which the skill of the civil engineer, the florist, and the landscape gardener are converting into a spot of rare and exquisite beauty.

"We present this week views of two of the buildings now rapidly nearing completion. The first is a representation of the Women's Pavilion, which is a noble monument of the energy and patriotism of the women of America. It is built by the exertions and under the supervision of the Women's Centennial Committee, and it is intended to be a place for the exhibition of all articles made or invented by women, and as the sphere of women has become so wide and comprehensive, the display in this building will be, in fact; an epitome of the whole Exposition. The Pavilion is located on Belmont Avenue, near the Horticultural Grounds, covers an area of 30,000 square feet, and is formed by two naves intersecting each other, each 64 feet wide by 192 feet long. At the end of these there is a porch 8 by 32 feet. The corners, formed by the two naves, are filled out by four pavilions, each 48 feet square. The whole structure is in modern wood architecture, roofed over by segmental trusses. The centre of the edifice is raised 25 feet higher than the rest of the building, and is surmounted by an observatory, with a cupola on top of the same, making the entire height of the building 90 feet. The interior of the building presents a very attractive appearance, but four columns obstructing the view, the main support of the roof being furnished by trusses resting on the outside walls. The panels are beautifully decorated with allegorical groups representing Faith, Hope, Charity, Art, Labor, Instruction, Religion and the Family, from designs by Camille Pitou, an artist who has done much towards the embellishment of the buildings on the Centennial Grounds.

"The Judges' Pavilion, intended for the use of the various Judges and Committees who are to award the prizes at the Exhibition, is almost completed, and will be one of the most attractive buildings on the grounds. It is built of wood and plaster and will be highly ornamented. It covers a space of 152 by 113 feet. In the centre of the building is a large hall, 59 by 78 feet, containing a platform and speaker's desk. A corridor ten feet wide runs entirely around this hall, and separates it in the rear from another hall, 28 by 59 feet. The partitions between these two apartments are so arranged as to be movable, and the rooms can be thrown into one, making a hall 59 by 116 feet. On each side of the building are seven commodious committee-rooms, opening into the corridor which surrounds the main hall, and three spacious rooms are provided in the front of the building. Two stairways lead to a gallery ten feet wide, running around three sides of the main hall."

THE INTERNATIONAL EXHIBITION OF 1876.—THE JUDGES' PAVILION.

Scientific American Supplement.
No. 8.
FOR THE WEEK ENDING FEBRUARY 19, 1876.

PUBLISHED WEEKLY,
AT THE
OFFICE OF THE SCIENTIFIC AMERICAN,
No. 37 Park Row, New-York.
MUNN & CO., Editors and Proprietors.
O. D. MUNN. A. E. BEACH.

The SCIENTIFIC AMERICAN SUPPLEMENT is uniform in size with the *Scientific American*. Terms of subscription for SUPPLEMENT, $5.00 a year, postage paid, to subscribers. Single copies, 10 cents. Sold by all newsdealers throughout the country.

COMBINED RATES.

The *Scientific American* and SCIENTIFIC AMERICAN SUPPLEMENT will be sent together for one year, postage free, to subscribers, on receipt of $7.00.

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MUNN & CO., PUBLISHERS,
37 Park Row, New-York.

WHAT NEW-YORK WILL SHOW.

FROM a two-column review of the work of our State Commission, in the *Tribune*, it would apper that New-York is quietly preparing for a creditable display. Fifteen hundred entries have been made from the State, with a bewildering variety of objects to be shown. Some of the displays will be of surprising magnificence; books, leather, furniture, machinery, and agricultural implements will probably occupy the more prominent position.

The gem of the fair will probably be the exhibit of the book trade. At the last meeting of the American Book Publishers' Association, it was decided that there should be a creditable representation of the trade at the Centennial. A competent committee was appointed to take the matter in hand, composed of Priestly Blakeston, and George Remsen of Philadelphia, N. R. Monachesi for Boston and New-York, and Henry Reck, the architect. These gentlemen were authorized to spend $30,000. They have given time and study to the duty intrusted to them, and having at command the valuable services of Mr. Reck, who made such a reputation at Vienna, and who received the Order of Francis Joseph in recognition of the merit of his work there, they have been able to complete designs for an elaborate and beautiful exhibit. The purpose is to erect, within the Main Exhibition Hall, an airy, artistic structure, two stories high, of iron and cabinet work, frescoed and decorated in the richest colors, to occupy a whole section. It will be open above and below, except as both stories will be filled with bookcases and pedestals. The second story will be supported on graceful columns, 12 feet high, and flanked all round with railings. It will be approached by a double staircase. In and around this structure all the great publishing houses of this city and the country will have a good representation of their publications of all kinds. Bookcases and pedestals are being built by each firm, in styles adapted to show their peculiar publications to advantage. The Bible Concern requires a certain broad form of case to display its full list of Bibles, in a hundred or more different languages, wide open to the view of the visitor; while a certain celebrated Directory man only needs a slender pedestal to show the one copy of one of his directories he has entered. Money is being freely lavished on these cases, from $1000 to $5000 being spent by the various firms on their several exhibits.

The leather trade will also make a special display. In the preparations for that event, the New-York manufacturers and merchants of that commodity are taking an active and prominent part, under the lead of Jackson S. Schultz and J. B. Hoyt. There will be a special building for this trade, 300 feet long by 160 wide, supplied with a 60-horse-power engine. The contract requires it to be built of wood and glass, in the same style of architecture as Machinery Hall, and to be completed by April 15th. It is to cost $30,750. All the leather, harness, shoes, pocketbooks, belting, etc., sent to the fair by the American trade will be grouped in this building. The number and character of the entries in this department of the exhibition, in which New-York State will occupy a conspicuous position, indicate that the display will be an extraordinary one. It will be larger and better than at all the World's Fairs, at London, Paris, and Vienna combined. Mr. Schultz is confident that the magnitude to which the leather industry has attained in America, and the excellence of its products, will be shown here in a manner that will surprise our own people. The general impression is that foreign leather is better than American leather; that Russia leather, for instance, can not be approached in this country. Our people will find out, at Philadelphia, that they have been mistaken in some respects. It is intended to show, among other things, that Americans can make better Russia leather than the Russians. Some of the processes of leather-finishing will be shown. As a central ornament in the leather trade building, a trophy will be erected, ornamented with bulls' heads, hemlock bark, etc., illustrating the history of leather-making in all its stages.

Forty-four furniture firms have secured space in the Main Building, and are making special sets and pieces, in the best style of workmanship, to place on exhibition. Marcotte, of this city, will send drawing-room furniture; Hertz will equip a chamber. Herter Brothers, the church-furniture firms, and various large chair and other firms throughout the State, will also make special exhibits.

An important part of the contribution coming from this State will be in the line of mowers and reapers, farm implements, and machinery. In the general exhibit of this class of manufactures, several hundred New-York firms will be represented. It is believed that very few, if any, of our large factories, whose products in any way constitute a feature of the industries of New-York, will not send to Philadelphia. A few are not yet entered which enjoy a national and even a foreign reputation; but it is expected that their names will yet appear in the record books at the headquarters of the State Commission before the Exhibition opens. A great deal of heavy machinery, printing-presses, steam rollers, stationary engines, and the like, will be sent on. The mowing-machine factories will place in Agricultural Hall specimens of all their patents. There will be 166 machines in competition. At Vienna there were only 71. The factories are not, as a rule, making special preparations, however. They prefer to take practical machines out of their warehouses for public occasions, making no changes in them except those that can be wrought with a paint-brush. The cotton and woollen manufacturers of the State will not be largely represented. They do not wish to be understood as placing themselves in the Exhibition in competition with the manufacturers of New-England. The merchants of New-York are spending a great deal of money in quiet arrangements for the fair. Their show-stands are making now, many of them after elaborate and artistic designs by Mr. Reck. Their construction is furnishing no little work to the cabinet-makers of New-York. Wigs, fashions, Tiffany's jewelry, Hartz's tricks, fire-arms, laundry-work, bustles, bird-cages, type-writers, carpets, New-York State wines, sewing-machines, rubber goods, busts, fishing-tackle, pianos, confectionery, locks, musical instruments, gold pens, wall-papers, soaps, safes, umbrellas, and a thousand other things, will be shown, and will each constitute a special display and be a special study of itself.

It is the desire of the State Commission to contribute to the art exhibition also. The plans of the gentlemen having the matter in charge are ambitious, but are not yet fully matured. The Commission have been able to save enough from the very limited fund placed at their disposal to make it possible for them to send all works of art from this State to Philadelphia free of charge to the artist or owner. They have therefore resolved to do this. The best artists and sculptors of the State will be represented in the art contribution. The number of entries from this State, it is ascertained from Mr. McElrath, is at present about 200.

BRAZIL AT THE EXHIBITION.

ALL the Brazilian exhibits have been collected and placed on view in Rio Janeiro. A correspondent of the *Herald* writes that the representation will not be as complete as was hoped, owing to the indifference of local authorities and manufacturers. Each province has made a separate and independent collection of its products, but no general classification has been attempted. The arrangement will give little satisfaction to students, but will enable the merchant to see at a glance where he may find the products he may need, and compare the quality of similar productions of different provinces.

Cotton of poor quality holds a prominent place in the collection. The great staple is coffee. But the general public will be more interested by the curious specimens of native costumes and the rude manufactures of the people, which are the truest measure of their place in the scale of civilization. From the Amazonas come hammocks gayly decorated with the brilliant plumage of tropical birds, and woven with no little artistic skill by the Indians, and still more curious costumes made from the bark of trees. The riches of this province reside in its forests, and here we have gathered together hundreds of specimens of hard woods which might easily be made a source of inexhaustible wealth. These Amazonian forests furnish also fibrous plants, like the white and flexible *acidud*, to take the place of hemp, and the *piassava* from which brooms well-nigh indestructible are made. The same forest formerly supplied the world with india-rubber; but this source of wealth is now seriously endangered by the reckless destruction of the rubber-yielding trees.

Ceara, celebrated for its coffee, sends samples of its chief staple, some cotton and a large collection of medicinal plants, that will well repay attention—among these the tree *Jaborandi do norte*, one of the most active sudorifics known to the pharmaceutist. One of the most striking features of the Exhibition is the great variety of alcoholic liquors. This branch of industry seems to have laid all the products of the country which contains an intoxicating principle under contribution. From Parana the most interesting product is the mate or Brazilian tea.

Most of the manufactured work which is not a specialty of Brazil comes from the provinces of Rio Janeiro and San Paulo. Compared with similar work done in Europe and America, it must be pronounced rude and unfinished. Among the new industries, the most notable is the establishment of a silk manufactory, and the introduction of silk-worms from China and Europe.

The immense interior districts of Matto Grosso, Goyoz and Minas Geraes have little in the way of manufacture to merit attention, but *en revanche*, they are rich in useful minerals, hard woods and diamonds. Even gold seems to be pretty widely distributed. It is not certain, however, that any of the precious metals exist in paying quantities. For the most part the cost of extraction exceeds the value of the mineral obtained. It is pretty well understood that mining operations, in so far at least as gold and diamonds are concerned, have ceased to be very remunerative investments. Judging by the number of jaguar and puma skins displayed by Matto Grosso, that province must be a perfect hunters' paradise, but otherwise not particularly attractive.

Geologists will be interested by a series of photographic views illustrating the structure of the Pernambuco stone reef, the geological features of the vicinity of Pernambuco and of the San Francisco River, besides some splendid views of the great Brazilian cataract, Paulo Alfonso, all of which go to Philadelphia. There is also a large collection of rocks from the coast of Pernambuco and the Rio San Francisco, and a number of beautifully preserved cretaceous fossils from new Pernambuco, some corals and other radiates. These are the results of a preliminary exploration undertaken by Professor Hartt and Mr. Orville Derby, of Cornell, before the full organization of the Geological Commission Corps. In a few weeks Professor Hartt will take the field with a large corps, and will continue the exploration of the coast provinces between Rio Janeiro and Pernambuco. It is flattering to our national vanity that this important scientific work has been intrusted to Americans. Considerable dissatisfaction is felt by the Brazilians on account of the incomplete representation of the native products and industries, and efforts will be made before the collection is forwarded to Philadelphia to render it more thoroughly representative.

A BRITISH VIEW OF THE EXHIBITION.

DISCUSSING the fitness of Philadelphia as the site of an International Exhibition, the *Anglo-American Times* observes that it is nearer the centre of the British Empire than any point in that empire; an advantage not to be overlooked in estimating the conditions of success for the enterprise. For this reason, "Philadelphia has an advantage greater than had London during either of the exhibitions in this metropolis, even to the inhabitants of the British Empire. The British Colonies of Australasia and of the settlements along the coasts of Asia can reach Philadelphia with much greater facility; indeed, Philadelphia may be said to be a station thence on the way to London. To the inhabitants of the Dominion, Philadelphia is a mere railway journey of two or three days. To the West-Indians, Philadelphia is a coasting voyage; and even from the United Kingdom the facilities enable it to be reached quickly, cheaply and readily."

But not only is Philadelphia a central point to English-speaking communities; the opportunities here offered for the investment of British capital are unsurpassed in the world. "The shocks lately experienced by those who have lent money to communities whose language they do not speak, and whom they do not understand, are turning the tide of investment more than ever to the United States, with the knowledge acquired that an ability to select is an essential requisite. Hitherto the British investor has been at the mercy of promoters and adventurers, to obviate which the readiest plan is to inspect the field for himself. He can proceed to Philadelphia and talk with intelligent men from every nook of the Union. He can then go West, and his eyes will be opened and new ideas imparted, which will enable him the more readily to dissect the statements made by the people who invite him to subscribe to their enterprises. He will learn wherein lies the advantage and the disadvantage of the Western country; the openings in the Eastern country. He will see how vast is the area of a State, and find how inviting to settlement is still even that he regarded as closed. Such travel will pay men with means, and what pays has an irresistible attraction. . . .

"What was there to attract an English trader to Vienna? The city was a place of which he neither knew nor cared to know; inhabited by foreigners who spoke an outlandish tongue, and were under regulations which he summarized as 'Russian, Prussian, Austrian, Military.' He did not want to meet Croatians, Wallachians, or Bulgarians; for he could not see what business was to be transacted, or how any connection, if made, could be maintained. But the case of Philadelphia is far otherwise, where he will find the representatives of the English-speaking communities from various parts of the world, with whom he can converse in his own language, dealing in money in which he can calculate, and sustain the communication after it has been opened. He will meet the men of the Dominion, fellow-subjects with himself, from the blue nose of the Atlantic to the red nose of the Pacific, and all down from the British line to the borders of Mexico, Americans will congregate, men ready to trade wherever they can see an advantage. There are then attractions beyond mere curiosity and pleasure, certain to bring a crowd of all classes to Fairmount Park during the year, and what is more, it is these who are likely to carry away as well as leave behind what will be productive of permanent good."

EXHIBITION NOTES.

THE exhibition space in Agricultural Hall is 236,572 square feet. The areas occupied by foreign nations will be as follows: England and her colonies, except Canada, 18,745 sq. ft.; Canada, 10,094 sq. ft.; France, 15,574 sq. ft.; Russia, 6785 sq. ft.; Spain, 6005 sq. ft.; Germany, 4875 sq. ft.; Brazil, 4657 sq. ft.; Netherlands, 4276 sq. ft.; Sweden, 2603 sq. ft.; Chili, 2493 sq. ft.; Belgium, 1801 sq. ft.; Japan, 1665 sq. ft.; Peru, 1632 sq. ft.; Liberia, 1536 sq. ft.; Norway, 1530 sq. ft.; Siam and neighboring provinces, 1220 sq. ft.; Portugal, 1020 sq. ft.; Argentine Republic, 969 sq. ft.; and Denmark, 806 sq. ft.

PENNSYLVANIA will occupy the largest space in Horticultural Hall. New-Jersey ranks next, New-York third, and California fourth. In the surrounding grounds, beautifully laid out with flower-beds, and traversed by smooth, broad avenues, England has been allotted 43,000 square feet of space; Germany, 10,000; Spain, 6000; the Argentine Republic, 5000; France, 3800; and the Netherlands, 200. At each of six different points a set of these avenues meet at a common centre, where upon a circular plot, 60 feet in diameter, will be erected an ornamental summer-house. Morocco has applied for permission to erect on one of these plots an elaborate structure illustrating what Moorish architecture was several centuries ago. In the flower-beds more than 32,000 hyacinth and tulip bulbs have been planted, and, with thousands of other beautiful and delicate plants, will be in full bloom on the opening day of the Exhibition.

IN the amount of space to be occupied in the United States Department of the Main Exposition Building, Pennsylvania is far ahead of all the other States, New-York being second, Massachusetts third, Ohio fourth, New-Jersey fifth, and Connecticut sixth. There is not an important business interest in Pennsylvania that will not be fully represented. Philadelphia exhibitors will be numbered by thousands. The classification of United States exhibits in this and in the other departments will not be geographical, but according to the nature of the exhibits.

CERTAIN rules of the Centennial Bureau of Transportation, relating to terminal charges, have been modified. On each separate article weighing 500 pounds or less, $1; on each separate article weighing over 500 pounds, 20 cents per 100 pounds, all of which must be prepaid. No terminal charge will be made on exhibits of live stock.

THE Secretary of the Treasury has decided to allow goods for the Exhibition without the customary oath to invoices, provided the proper commissioner of the foreign government shall certify under his official seal that the articles described in the invoice are intended in good faith to be exhibited at the International Exhibition of 1876 at Philadelphia. Should such goods be withdrawn from the Exhibition for sale or consumption in the United States, an invoice sworn to as heretofore prescribed will be necessary.

THE Centennial Mail Service, which embraces the carriage of the mails from the Philadelphia Post-Office to the Centennial Grounds, has been let by the Post-Office Department to Thomas Gannon, of Philadelphia. The contract calls for five wagons and ten horses. The wagons, of a handsome design, are to be of the very best workmanship, with all the equipments, such as harness for the horses, cushions, coverings, etc., to correspond. The messengers, five in number, will wear uniform clothing, and it is stipulated that of the ten horses, five shall be of a bay color, and the others dapple gray.

THE embossed stamp of the Centennial stamped envelopes is shield-shaped, bearing at the top and in a scroll the words, "United States Postage," beneath which is a representation of a mounted post-boy on ground work of telegraph-poles and wires. Beneath this is an engine and postal-car, and at the bottom of the shield, within a scroll, are the words, "Three Cents." The dates 1776 and 1876 are at the top and bottom of the shield respectively. The stamped envelopes will be manufactured and sold in the Government Building on the Centennial Grounds, and will be furnished under the present rates for stamped envelopes without additional cost. These envelopes will not be furnished by the government to any post-office excepting the Philadelphia office, and only one denomination (three cents) will be manufactured, with only one

size and quality of envelopes—namely, that which is known as No. 3, full letter, first quality envelope. These are not intended to supplant the present three-cent envelope, but are additional thereto, and their issue will be discontinued at the close of the Centennial.

THE Agricultural Bureau proposes to arrange for two special displays of dairy products, about June 20th and October 20th, each to last a week or so, and to each of which about 5000 cheeses will be sent. A model factory will be built, after the best type of those establishments, fully equipped with tastefully constructed apparatus. In addition to this, there will be a continuous exhibit; and some of the best factorymen of New-York have, for this special object, cheese of 1873, '74 and '75, and will add from the make of the present year to the list. It is proposed to give every factory in the country the opportunity of sending one or more cheeses for exhibition. By dividing the time into five parts, and allowing each factory to send two cheeses, it is proposed that say a thousand cheeses will fill the shelves continuously, these being cleaned off every four weeks to make room for a fresh lot.

Should it be thought desirable to exhibit the very interesting processes of manufacture, this can be done. Fifty cows at Philadelphia can be obtained to supply milk for the purpose. Nearly that number have already been promised. Whether this will be done, however, depends primarily on whether money enough is raised to build the factory; and, secondly, on the wishes of the dairymen. There is a prejudice among dairymen against exhibiting the processes of manufacture, lest foreigners, by carefully watching them, shall steal our fine art of making superior cheese, and injure us in the markets of the world. Our export of cheese is large and profitable, amounting now to about 80,000,000 pounds annually, and it is desired to extend the business rather than imperil it in any way. As the Canadians and English will be present in the agricultural department in force, perhaps a good show of products is all that will be made.

MANY apiarians are preparing articles for the bee department of the Centennial Exhibition. John Long, of New-York, is having constructed two observation hives of ornamental wood, richly carved antique Swiss style—one for an Italian swarm, the other for a black swarm. The queen and inside workings of the hives will be fully displayed; the flight-board turned toward the wall of the building, which he will get permission to pierce, and run a short tin tubing out from the hive, putting little flight-boards outside the building. He also will have two microscopes mounted on stands, with black and Italian bees under each, entire and dissected, mounted in the best way. In addition, he has specimens of the bees' industry, such as glass castles filled with honey, curiously wrought urns, etc., also specimens of comb, strained honey and beeswax from England, Scotland, Cuba, Texas, Chili, and our own country.

AT a late meeting in Chicago the National Poultry Association elected John E. Diehl, of Philadelphia, Philander Williams, of Taunton, Mass., and Edward S. Lamb, of Chicago, with power to add two Eastern fanciers to their number, to serve as a committee to superintend the poultry show at the Centennial, to come off in the latter part of October.

THE Centennial Medical Commission, S. D. Gross, M.D., president, has made arrangements for the holding of the Centennial Medical Congress in Philadelphia from the 4th to the 9th of September. The Congress will consist of delegates, American and foreign, the former representing the American Medical Association and the state and territorial medical societies of the Union; the latter the principal medical societies of other countries. The morning sessions of the congress will be devoted to general business and the reading of discourses; the afternoons to the meetings of the sections into which the work will be divided.

IN the Women's Building none of the exhibits will be classified. A large portion of the northern section has been set apart for the Art Department. The northwest corner has been assigned to the Art School of Cincinnati, which will exhibit furniture designed and carved by the ladies of the school, with paintings, etc. In the east end will be a large music gallery. There will also be a section for the representation of women's work—engraving, book-binding, lithographing, etc.—and another for patents. Only goods manufactured by women will be received. The building will contain offices, parlors, and other conveniences.

THREE classes of works of art are called for by the American committee: Works by living American artists, by deceased American artists, and works of foreign artists belonging to residents of the United States. All works must be of a high order of merit, and will be admitted whether previously exhibited or not, and without charge for space. They must be sent to the gallery at No. 625 Broadway, New-York, between March 1st and April 1st, for consideration by the committee of selection.

THE French Commission have selected 670 pictures for exhibition at Philadelphia, including the "Declaration of Independence" and the "Surrender of Yorktown," by Charles Edward Armand-Dumaresq; "Old and New California," by Bartholdi; "A Portrait of Washington," by Princeteau; several works by Messrs. Jean Pierre Alexandre Antigna, Jean Victor Adam, Auguste Alexandre Philippe, Charles Blanc, Brest and Alfred; also one hundred sculptures, and sixty engravings and designs.

AMONG the works of art which will no doubt be exhibited at the Centennial is a portrait of Washington woven of silk in the Jacquard loom, which C. S. Goodrich, our former consul at Lyons, procured to be made. These silk portraits are made for the royal families of Europe; it takes two years' time and from $10,000 to $20,000 to construct the machinery for each one, and, when a court order is filled, the machinery is destroyed. This of Washington is the first ever made for other than royal customers. The pictures resemble steel engravings in their delicacy and clearness, and those made fifty years ago are as perfect in color and shade as when first made. The Washington was copied from an engraving of Stuart's portrait in the Boston Athenæum, and Mr. Goodrich procured a copy for New-York, Philadelphia, and Boston, and one for himself, and, besides these, not half a dozen were secured by American citizens.

MRS. GREATOREX has made a collection for the Museum of Curiosities at the Centennial which is valuable and interesting. Among them are relics of the old Dutch Church in Fulton street, New-York; a piece of needlework executed by the Empress Josephine; a bedspread, spun, designed, and woven by an aunt of George Peabody; a richly carved old cabinet, once the property of Daniel Webster, and some china and other things belonging to Aaron Burr, General Lafayette, and George Washington respectively.

IN the main building the Spanish section will occupy an area of 11,253 square feet, situated in the west wing. On one side will be Russia, on another Egypt and Tunis, and on the third Canada. At the entrance to the section from the central isle it is proposed to erect a triple arch of highly ornamental appearance, crowned by trophies of flags, and by a large painting representing Spain as a woman drawing aside a curtain and revealing the Western hemisphere.

IN the Agricultural Hall, Spain will fill a space of 6000 square feet, and here will be displayed most of the products of her colonies—the coffee and sugar of Cuba and Porto Rico, and the hemp, spices, mother-of-pearl, and tortoise-shell of the Philippine Islands—as well as the oranges, raisins, olives, figs, and generous wines of the mother country. The colonial exhibit is being formed by local commissions—one in Cuba, the other in Porto Rico, and a third on the Philippines, under general directions from the Central Commission at Madrid.

IN the Art Department, Spain will make a very creditable display, occupying one half of the large west gallery in Memorial Hall, and one of the small square galleries in the Annexe. The Commissioner is not in possession of any details as to the number of pictures or the names of the artists contributing, but he is informed that the collection will contain examples of all the best modern painters, including many works of great value selected from the royal galleries.

A BUILDING illustrating Moorish architecture will be erected on the grounds, and in it will be quartered a detachment of soldiers from the Royal Engineers of Spain, composed of a lieutenant, a sergeant, a corporal, and twenty privates. The Government at Washington has been asked to grant permission for the invasion of our soil by this miniature Spanish army, and it will, of course, not hesitate to do so. The soldiers will come armed and uniformed. They will act as guards in the Spanish department, and will take part in parades and other occasions of ceremony.

To defray the expenses of the participation of the Argentine Republic, the sum of $52,000 in gold has been appropriated by the Argentine Congress, and a further sum of $20,000 gold to defray the cost of a work descriptive of the country, which is being published in five different languages. There will be over 30,000 articles placed on exhibition from this country alone.

THE Canadian Centennial Commission report their work in a forward and satisfactory condition. New-Brunswick will contribute a column of polished red granite sixteen feet high by three and half feet in diameter, raised on a base of brown olive and gray stone. The Manitoba collection, which consists principally of agricultural products and Indian works, is all ready for shipment. Nearly all the specimens from British Columbia are now at Montreal. With reference to the exhibition of cattle, it is stated that the Commission will pay the cost of transportation and feed, but the owners must be responsible for care-taking, damages, accidents, etc. Probably the steamer Lady Head will convey the goods for exhibition from Halifax and St. John to Philadelphia, where the crew will be employed and the steamer retained as a boarding-house, thus saving vast expense.

THE Resident Commissioner to the Centennial Exhibition for the Republic of Liberia has received official information of the withdrawal by the government of that country of the appropriation formerly made—$10,000—for a display of its products. Mr. Edward S. Morris, the Commissioner, had already collected a quantity of coffee and palm-oil soap, and had made arrangements for procuring specimens of all the other articles of commercial value produced by the country, such as sugar, indigo, spices, ginger, arrowroot, gums, ivory, and hard woods, and he is not willing now that Liberia should step out for want of a few thousand dollars. He has proposed to President Payne that the Government should place $5000 in the hands of a member of Mr. Morris's commercial firm, now on St. Paul's River, that he should purchase the articles needed for the Exhibition, and that they should be sold here at the close of the Fair, and the proceeds, less expenses, returned to the Liberian Treasury. If this offer is not accepted, the Commissioner will make such a display as he can with the articles on hand, but it will, of course, be incomplete and unsatisfactory.

THE Centennial Committee of New-Hampshire have adopted a plan for a State building, to be 30 by 40 feet, two stories high, with projecting and spacious piazzas on three sides. The location is one of the best, and commands a fine view of the grounds. It is proposed to appeal to the citizens of New-Hampshire to contribute toward the erection of the building, and in making a creditable exhibition of the various industries of the State.

MONEY has been secured and plans have been drawn for the erection of a building upon the principal avenue of the Exhibition grounds at Philadelphia for the accommodation of the interests of Massachusetts and the entertainment of her guests.

THE entries thus far from the State of New-York are to the number of 1500 more than there are from England, and cover displays in almost every branch of art and industry.

A MEETING was held in Trenton, January 26th, to arrange for a full representation of the agricultural, horticultural, and mineral resources of New-Jersey. Governor Bedle presided. It was decided to appoint county committees to raise the necessary funds and to secure a satisfactory representation of cereals.

THE new depot of the Pennsylvania Railway will stand just outside the grounds, near the main entrances. The general waiting-room is to be 100 by 130 feet, the ticket-offices 40 by 30 feet, the ladies' waiting-room 81 by 100 feet, and the baggage-room 49 by 100 feet. There will be three platforms, built in a semicircular form, 1650 feet long. When trains arrive, the engineer will see by a signal-box placed at the switch on the straight track outside what siding is clear, and will go to the one he is ordered. The arrangement for separating the passengers for different points—north, south, and west—will be carefully made, and great completeness and system in this respect is promised, so that the confusion incident to such an occasion may be lessened.

THE West-Virginia building is located very near the British buildings, and will be constructed entirely of West-Virginia timber. The exhibition of that State promises to be very complete, and will embrace sections of coal-seams 8 to 9 feet thick, and of timber from 3 to 10 feet in diameter. The State appropriation for Centennial purposes is $20,000.

AN appropriation of $20,000 has been asked by the Colorado Commissioners, and as their exhibits are all ready to be forwarded, it is deemed certain that the Legislature will pass the bill.

THEODORE THOMAS has consented to take charge of the musical ceremonies at the opening of the Exhibition, and in a letter to Mrs. White upon the subject, he thanks the Women's Centennial Committee for the interest taken in the matter, and says it is a proof that art and culture in this country can only look for support and encouragement among the women.

THE headquarters of the New-York Commission, which is now under contract, will be built by the side of the expensive residence of the British Commission. It will be of the summer cottage style, and an ornament to the grounds.

THE Centennial work of the African Methodist Episcopal Church of Philadelphia will be the erection of a statue, cost $3500, to its founder, Richard Allen.

THE proposition to erect an emancipation monument in Fairmount Park, and unveil it on the Fourth of July, meets with favor among the colored people. Rev. Andrew J. Chambers is lecturing on the subject in the South, taking up collections in behalf of it as he goes.

THE Hartford, New-Britain, and New-Haven societies of the Schuetzen Verein are the latest that have entered the lists for the proposed immense demonstration by that institution in Philadelphia this summer.

DR. C. C. COX, permanent chairman of the National Sanitary Commission, has issued circular letters to sanitarians, inventors, manufacturers, and others, requesting models for the Centennial Exhibition illustrative of the material progress of public health and safety, including approved apparatus for the protection of life and limb.

LABORATORY NOTES.

By SERGIUS KERN, St. Petersburg.

(1) *On a Reagent for Uranium.*—With potassium ferrocyanide (K_4FeCy_6) a solution of a uranic salt yields a brown precipitate of uranium ferrocyanide. The precipitate obtained much resembles the precipitate of copper ferrocyanide, but may be distinguished by the solubility of the precipitates in hydrochloric acid—namely, the uranium ferrocyanide dissolves easily even in diluted hydrochloric acid; the corresponding copper salt is insoluble in acids. This reaction may be used for the separation of copper from uranium. The uranium ferrocyanide dissolved in hydrochloric acid with a few drops of nitric acid gives a *green coloration* after being boiled for some minutes. This reaction is proposed as a test for uranium salts.

(2) *On the Use of Cuprous Oxide.*—This compound is easily prepared by boiling a solution of copper sulphate with sugar and an excess of caustic potash. As the cuprous oxide (Cu_2O) obtained in the form of a red powder is soluble in ammonia, and absorbs readily free oxygen, it is proposed to substitute it for the expensive pyrogallic acid now used in laboratories for the absorption of oxygen. Pyrogallic acid must be very carefully preserved, on account of the great avidity of this substance for oxygen, whilst cuprous oxide may be easily conserved in a dry state, and, when necessary, dissolved in ammonia. A solution of cuprous oxide in ammonia absorbing oxygen gas turns blue, owing to the formation of cupric oxide (CuO). The solution of cupric oxide obtained may be again converted into a colorless solution of cuprous oxide (Cu_2O) by placing in the liquor a clean copper wire. The formula $CuO+Cu=Cu_2O$ explains this reaction.

CONSTITUTION OF THE PHOSPHATES.

By MM. BERTHELOT and LOUGUININE.

IN this memoir, the authors examine the formation of an insoluble phosphate—that of baryta; they undertake an alkalimetrical study of phosphoric acid; and, finally, they seek to define the displacements and reciprocal distribution of an alkaline base among phosphoric acid and the nitric, hydrochloric, and acetic acids. They conclude that phosphoric acid is not a tribasic acid of the same kind as citric acid, as the third equivalent of a soluble base is separated from phosphoric acid by the feeblest actions, and even by dilution. With ammonia it happens that this third basic equivalent does not combine with phosphoric acid, or if it combines at first, it does not remain definitely united to the acid, but is gradually separated spontaneously and completely. Neither is phosphoric acid a bibasic acid in the same sense as are the sulphuric, oxalic, or tartaric acids. The second base, as alkalimetrical operations show, is not neutralized by phosphoric acid, and is entirely separated by the hydrochloric and nitric acids, and gives indications of division even with acetic acid. In short, the three equivalents of base united in the phosphates considered as normal are combined in different and unequal manners. Phosphoric acid must be regarded as a monobasic acid of a mixed function.

EXTRACTION OF SULPHUR.

C. F. SESTINI.—Having observed, in the Romagna, a workman carefully picking out crystals of gypsum mixed with sulphur ore, before its introduction into the *doppione* (a furnace receiving a double row of retorts), he was told that in the furnace gypsum destroyed the sulphur. On investigating the reactions ensuing when gypsum and sulphur are heated together, he found that at 130° the gypsum lost all its water and became anhydrous. At higher temperatures, up to 444°, the sulphur reduced the sulphate of lime to a sulphide, and escaped as sulphurous acid:

$$CaSO_4+2S={}_2SO_2+CaS.$$

STENOGRAPHY.

ON November 1st, a Stenographic Exhibition was opened in a room of the Pedagogic Museum of the College, Rome. Stenography at the present day occupies a very important part in the requirements of public life, and we believe the effort to encourage its study by a public exhibition will lead to useful results. On the walls of the room were a list of the Italian towns that had a school or society for stenography. The only method followed is that of Gabelsberg-Noe. On a table in the centre of the room were stenographic attempts of every kind, from large plates for elementary study to the smallest and most minute works. In one case, Dante's "Divine Comedy" was copied out into a book of Lilliputian dimensions. On a post-card one stenographer had written 3660 words. The committee who arranged the exhibition wish to reproduce on the historical wax tablet the stenographic marks with which Tiro wrote the speeches of Cicero.

LESSONS IN MECHANICAL DRAWING.

By Prof. C. W. MacCord, Stevens Institute.

(Continued from p. 94.)

Lesson IV.

We have more than once insisted, that control over the pencil or the pen, and familiarity with the uses and manipulation of the triangles, are to be acquired only by the *repetition* of exercises such as we have given. The way to learn to draw lines is, to draw lines; and in order to draw them well, the best method is at first to make the drawing of the line, as such, the end and object of the exercise. Supposing this to have been conscientiously done, the beginner should by this time have reached, not perfection by any means, but a point at which he may with profit and with much more satisfaction enlarge his sphere of operation, and relieve the monotony of his previous practice by introducing the element of form; in short, by drawing lines which represent something. He will very naturally desire that they should represent something either useful or ornamental, or both. Now, were it our special object to qualify our readers in the shortest possible time to become mechanical draughtsmen, in the sense of being able to make drawings of machinery, we should very naturally, in our turn, select as subjects for practice the simpler details of machinery. But this is not the special object of these papers. We are addressing, not an assemblage of mechanics, or those solely interested in mechanical matters, but a mixed audience, and we may, and hope we shall, attract the attention and excite the interest not only of those we have mentioned, but of many others. And among them we trust there may be not a few who are either too young to study mechanical details—nay, even to understand the principles involved in drawing them—or too old to care to devote their time to them—not a few even to whom things useful, in that sense only, may be distasteful or absolutely useless. And this is the reason for selecting the exercises to which this and some following lessons will be devoted. We do not use the term mechanical drawing in the restricted sense frequently, perhaps usually, attached to it—and our meaning would be more precisely expressed by the phrase, drawing mechanically, as distinguished from free-hand sketching—a phrase which defines itself, and includes every thing that can be drawn, the pattern of the carpet as well as the plan of the house, a new design for a woven fabric as well as the loom that makes it, the ornamental device as well as the useful machine; in short, it embraces the whole structure, from roof to foundation.

Fig. 36.

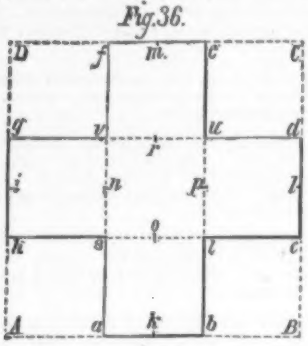


Fig. 37.

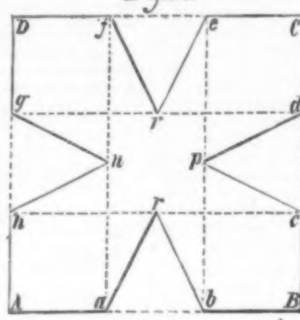


Fig. 38.

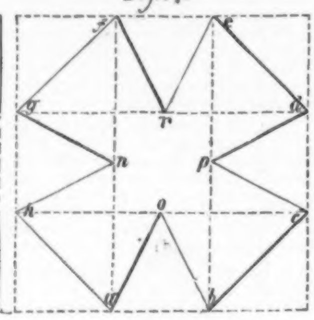


Fig. 39.

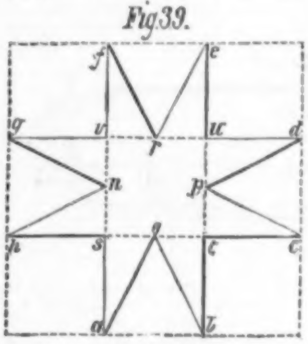


Fig. 40.

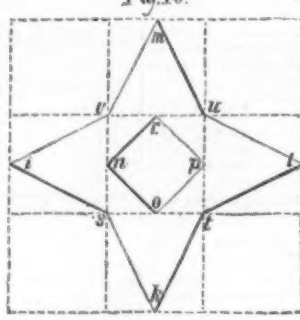


Fig. 41.

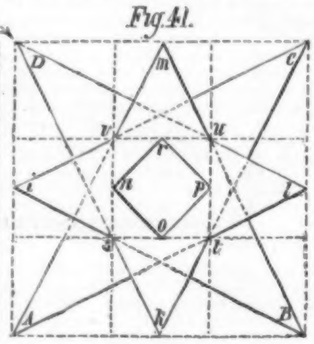


Fig. 42.

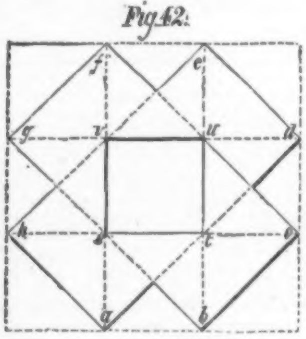


Fig. 43.

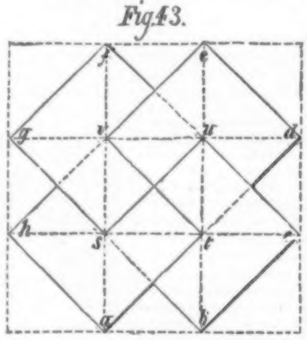


Fig. 44.

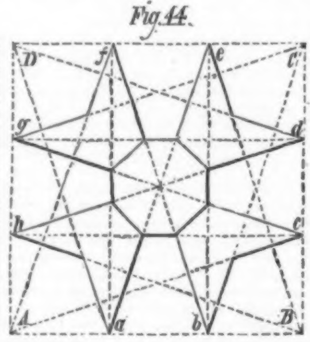


Fig. 45.

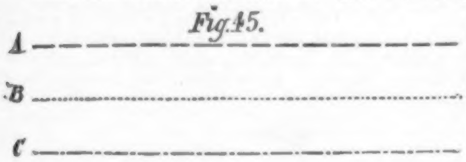


Fig. 46.

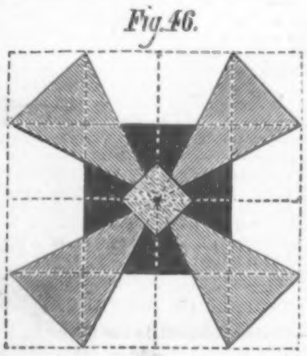


Fig. 47.

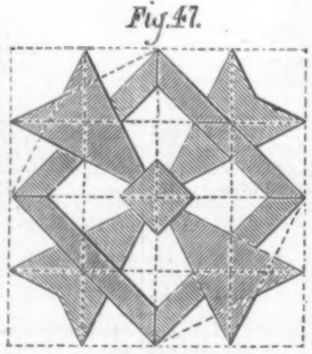


Fig. 48.

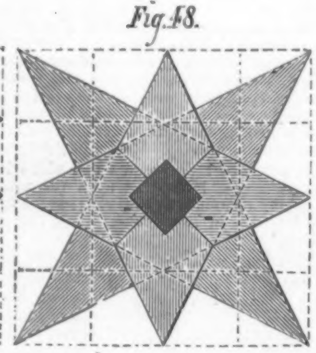


Fig. 49.

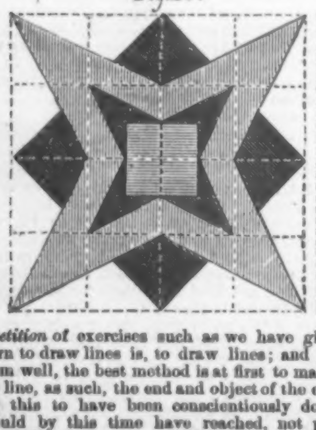


Fig. 50.

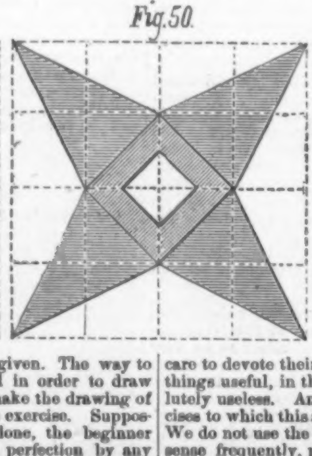
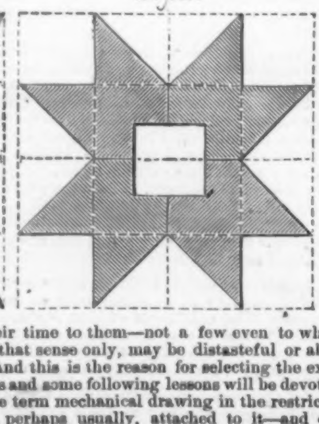


Fig. 51.



This has been mentioned before; but we speak of it again here, because some, to whom the term which we have preferred to use conveys the limited meaning above alluded to, may say, "Why, these are not mechanical drawings at all; they are only fanciful figures, good to look at, possibly, and to amuse children, but nothing more."

Precisely so, utilitarian friends, they are put here to look at; and it may be that your children one day will show you, if we do not, that you have said three words too many, "but nothing more." For ourselves, we entertain the hope that they may derive instruction as well, and, on the whole, are not quite sure but that possibly their fathers might. All are not cast in the same mould; and such "fanciful figures" as these may arouse a latent taste or talent, and lead to its cultivation, which without them might have remained dormant. We therefore give the children the benefit of that chance, and proceed, with the assertion that no one, of any age, who has set out, as we have supposed, with no previous practice, will find the time wasted which may be devoted to the careful execution of the designs herewith presented.

In Fig. 36, A B C D is a square; the sides A B, B C, being each divided into three equal parts, by the process explained in connection with Fig. 35, and the opposite points of division joined by lines parallel to the sides of the square, it is subdivided into nine smaller squares. The sides of the large square are also bisected, at *i, k, l, m*; and likewise those of the central small one, at *n, o, p, r*.

By joining the points thus determined, in various ways, by right lines, the series of different forms, Figs. 36–44, are produced. In each of these we have repeated the division as above explained, in dotted lines, and the lettering being alike in all, it is presumed that the reader will be able to trace the construction without further assistance, which indeed it would be difficult to give.

It is, however, proper to remark, that the dotted lines which we have drawn are merely what are called "construction lines;" and if the object be to draw the forms only, without preserving a record of the process by which they were laid out, they are to be pencilled in as lightly as possibly, and after the inking is finished they are to be erased. But we advise the drawing of two series, in one of which these lines shall be preserved, by dotting them in, as shown in the diagrams. And this leads us to say a word in regard to the style in which this should be done. The term *dotted*, as applied to the lines of a mechanical drawing, is not strictly accurate, as it is clearly impossible to make round dots with a drawing-pen; but custom sanctions the calling of a line dotted which is in reality composed of alternate dashes and spaces. Now if these dashes and spaces be long, as shown at A, Fig. 45, no matter how regular they may be, the effect is as though the line had been hastily and carelessly drawn, whereas nothing adds more to the finish of a drawing than to have the dotting *fine* and regular, as at B.

Considerable practice and much care are required in order to do this dotted work satisfactorily, and it is, we admit, tedious; but still the beauty of a drawing is so much enhanced by its being neatly done, that we consider in all cases that when the time can possibly be spared for this purpose, it is time well spent. Another style of dotting is shown at C in the same figure; it consists of a long and a short dash alternately, and when time presses this style may be advantageously adopted, as it can be executed more rapidly, and the effect of irregularity in the spacing is not so conspicuous; and besides, the dashes may be made longer without marring the finish to so great an extent.

Another point deserves remark. We have said that lines should be smooth and even, whether fine or heavy; but nothing has been said about how fine or how heavy they should be under different circumstances. Now, it is not easy, if indeed it be possible, to give any absolute standard; but it may be stated as a safe general principle, that the smaller the drawing the finer the lines should be. Beginners are apt to think that exceedingly fine lines display a greater degree of skill, but it is possible to go to an extreme in this direction as well as in the opposite; too fine lines give a large plan an appearance of tameness and faintness, while too heavy ones make it look coarse. The golden mean can be acquired only by experience; and having given the general guide indicated above, we can do no more, except to say that no serious error will result from taking the lines of our illustrations as examples. We may, however, add a caution against excessive thickness of shadow lines; many mechanical engravings, especially those by German artists, are faulty in this respect.

In Figs. 46–51, we have in each case a large fundamental square, subdivided into sixteen smaller ones, the sides of the large one being divided each into four equal parts, and the points of division being as before joined by parallel lines. The adjacent sides of the four central squares are also bisected, and these points of bisection are joined to form the smaller central square in all these figures except 49 and 51, in which lines are drawn through the same points, but parallel to the sides of the original square, instead of at angles of 45° with them as in the others. The necessary "construction lines" being dotted in as before, nothing need or can be added in the way of explanation, so far as the "laying out" of these figures is concerned. By way of further practice, the line-shading with which this series of figures is finished may be attempted; but in order to guard against the disappointment frequently attending first efforts in this way, the beginner will do well to practice some first upon some surface of the same size, before trying his hand on his drawings. The lines of the shading should be, for the lightest tone, finer than the outlines of the figures; the ink should be a little thinner than is used for the outlines; and shading should not be begun until the whole work is inked in, and the paper well cleaned; and, finally, the shadow-lines should be left till the very last.

(To be continued.)

Steam is reckoned to be ninety times cheaper than manual power, seventy times cheaper than electro-motive power, and ten times cheaper than horse power.

[New-York Medical Journal.]

NEW SPHYGMOGRAPH, AN INSTRUMENT ADAPTED AS A SPHYGMOGRAPH, SPHYGMOMETER, CARDIOGRAPH, CARDIOMETER, AND TO OTHER USES.

By A. T. KEYT, M.D., Cincinnati, Ohio.

THE new sphygmograph is constructed upon the principle of utilizing elastic membrane and a liquid, as water or alcohol, to receive and transmit to the tracing-lever the movements of the pulsating artery, in place of the steel spring and rigid bar used for the purpose in the instruments already before the profession.

FIG. 1.—THE SPHYGMOMETER.

Elastic membrane and such liquids are so closely allied in physical properties to the arterial coats and the blood as to constitute them very natural media for the purpose indicated. The one, in its trueness and delicacy of response to distending force, and certainty of instant return to its former state when the force is removed, is exquisitely adapted to receive the impressions of arterial movements; and the latter, in its lightness and practical incompressibility, with its quick facility of movement in the direction of least resistance, is no less nicely adapted to receive and transmit these impressions.

The instrument represented in Fig. 1, we name the sphygmometer, and whose uses we shall more fully describe later on.

The base or receptacle, *a*, is made of thin brass; it is semi-circular in form, with an oblong free edge below, and a shallow neck, *b*, above, into which is inserted, air-tight, the glass tube *c*. The free edge of the base measures inside one inch and three eighths in length by three eighths in width; and over it is drawn, by means of a special device, presently to be described, a rubber membrane, air-tight, and just tense enough to secure its smoothness and integrity of action.

The glass tube is eight or ten inches long, of small bore, and graduated in inches, halves, and quarters. If the base be now filled with water to the top of the neck, the instrument is ready for our purpose.

If, first, we properly press the base directly over an artery, as the radial, the elastic floor expands, closes round, and accurately fits the vessel as the segment of a sheath, the liquid in the mean time rising in the tube in proportion to the expansion upward of the basic membrane. The elastic coat so embracing the artery will move exactly with its movements, rise and expand with its diastole, fall and contract with its systole, and be impressed by all its minor changes. There is a degree of pressure at which the tension of the membrane so counterpoises the tension of the artery as best to develop these movements. We will suppose the particular point attained, the liquid column measuring a corresponding height. The superimposed liquid, pressing the basic membrane at all points, reserves and instantly conveys the motions so impressed upon the latter, to the column in the tube, where they reappear as distinct undulations. These undulations are true and exact pulsations of the artery, transferred to the liquid in the tube.

If, second, while all is *in situ*, and the liquid in the tube oscillating, say from four to four and a half degrees, we suppose the tube shortened and the end expanded into a small shallow cup, just at the height where the undulations, now greatly reduced by the increased area occupied by the liquid, will rise a little above and fall a little below the level of the rim, and suppose fixed over the top a thin, elastic membrane, air-tight, the pulsations that were seen in the liquid will now be manifest in the disk, which will be seen to rise and fall in exact obedience therewith.

If, third, a pin be placed with its thin, flattened base fixed to the centre of the disk, and its point impinging against the under side of a light lever moving on a delicate attachment,

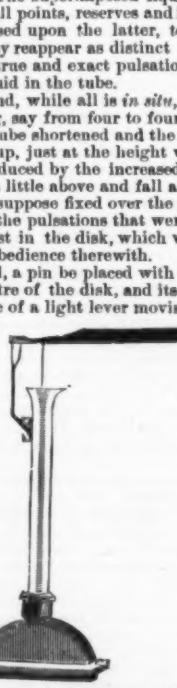


FIG. 2.

the motions may be amplified to the required extent, and the point of the lever will represent, just as the column in the tube, the movements of the artery (see Fig. 2).

The Construction.—The principle established as true and effective, it remained to adapt mechanical contrivance, so as best to develop and carry out the principle. After much study and experimentation I have settled upon the basis of the following plan, embodied in the simple instrument shown in the cuts Figs. 3 and 4, which I proceed to describe and explain:

The central receptacle or base, *A*, is essentially of the form and dimensions as represented in Fig. 1. In order to secure the basic membrane at the lowest level, air-tight, and uniform in its tension, and withal an easy way of placing and replacing the same, the base is made in two parts (see Fig. 5). We place the rubber cloth, of selected quality, lying flat and natural, upon the lower flange; then pass the upper regularly into the lower part, the membrane gliding and stretching over the advancing edge, until all is brought in contact, and then make tight by screws, one at each end. Between the two parts the adaptation is such that, as the flanges are approximated, the membrane closes the chamber air-tight before these are in close apposition, an arrangement by which we are enabled to regulate the tension of the membrane in accordance with a rule to be presently stated.

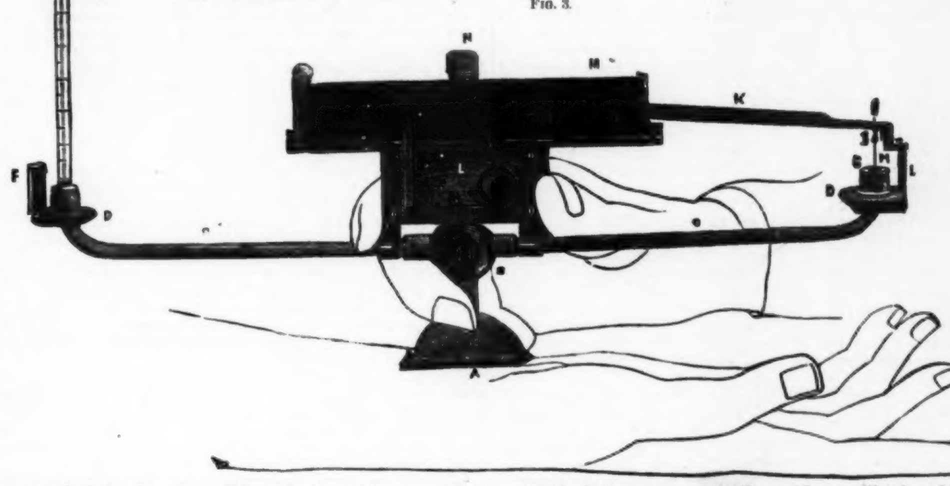
The chamber opens above into a short tube, which is made continuous by a screw-joint with the vertical limb of a three-way stopcock, *B*. Extending from the horizontal limbs are two small brass tubes, *C*, *C*, one on each side, in all respects symmetrical with each other, and formed as seen in the figure. Fixed to the curved extremity of each tube, at the same level, is a smooth, well-finished hinge, *D*, *D*. Each tube opens up through the lower attached leaf of its respective hinge, by a small cup one quarter of an inch in diameter. Directly over one lateral cup, the near leaf of the hinge is perforated by a small opening, which communicates with the graduated glass tube, *E*. The arrangement by which the glass tube is kept securely in place is by a shallow brass tube with a screw cup attached to the upper lid, with its centre over the opening; the glass tube surrounded by a short section of rubber tubing, being introduced, the cup is screwed down and all made tight and firm. The distal leaf *F*, provided with a rubber disk, is for the purpose of closing the cup when the tube is lying down and the instrument not in use. Placed level, without arching or cupping, accurately over the other lateral cup, is a thin elastic membrane. This is secured in the upper leaf, so that when it is fastened down the cavity is closed air-tight. The regulation of this small disk is the nicest part of the whole instrument. A special apparatus is required to insure just the right tension, to prevent bagging or irregularity of surface, and yet allow the freest motion attainable, and also to provide for uniformity in the sphygmographs. The device *G* effects these purposes satisfactorily. It is simple and easily understood when seen, but its description here would be tedious, and therefore is omitted. A light pin, *H*, of proper length in vertical position, is attached by its thin flat base to the centre of the disk. From the distal end of the lower leaf, a perpendicular bar, *J*, rises, which gives support to the nice mechanical adaptations required by the tracing-lever. The latter moves on fine pivot-points, and its fulcrum can be moved nearer to or farther from the line of the pin. The point of the pin is directed by a small, hollow cone, *I*, to the place of its lodgment in a small socket made in the end of a delicate steel screw, the same forming the apex of the cone. The said screw traverses a slide, which fits closely to the base of the lever, and upon which it can be moved to or from the fulcrum, of course carrying the screw with it. The office of this fine screw is to provide an easy way for the nice adjustment in length required by the pin. And the adjustment of distance between the vertical pin and axis of the tracer may, if thought desirable, be effected in like manner by screw adaptations. Thus, by these arrangements, the tracer moves with the least possible friction; the distance between its fulcrum and point of power can be readily changed, so as to give a greater or less sweep of its point, and its line can be raised or depressed to the right degree. The lever *K* is five inches and a quarter long, with firm metal base and light steel point bent at an angle. The intervening point is of wood, made thin, but of sufficient width to prevent any vertical spring. There is no attempt at counterpoise, the lever being made as light as can be; it rises on the pin and falls on the same by its own weight.

The three-way stopcock *B*, when the key is horizontal and indicated side up, permits free communication between the central receptacle and lateral branches. If the key be turned to the vertical, from left to right, communication is cut off with the pin-branch and opened up with the tube-branch. On the contrary, if the key be turned to the vertical, from right to left, communication is cut off with the pin-branch and opened up with the tube-branch.

The watch-work *L* is placed directly over the central transverse line of the instrument, and is secured by screws to arms of metal attached to the lateral tubes near the limbs of the stopcock. It is patterned after the watch-work on Marey's sphygmograph, only it differs from the latter in having a mechanism for increasing or slowing the speed of the travelling stage. The latter, carrying the smoked glass *M*, is sufficiently shown. The cylindrical body *N* is a reservoir for liquid. It is provided with a close-fitting top, and a stopcock arrangement at the bottom, communicating with a small tube which leads to the vertical limb of the stopcock *B*.

FIG. 3 represents the instrument in the act of taking the radial pulse: *A*, the base; *B*, the 3-way stopcock; *C*, *C*, the lateral tubes; *D*, *D*, the hinges; *E*, the graduated tube erect and the liquid standing at 4°—the same seen empty and turned down in Fig. 4; *F*, the distal leaf that closes the opening when the tube is down; *G*, the contrivance for fixing the small disk; *H*, the pin with its base in the disk, and point in the socket *I*; *J*, the arm which supports the lever and its mechanism; *K*, the writing-lever; *L*, the clock-work; *M*, the smoked-glass slide on the carriage, showing the first part of tracing; *N*, the reservoir, shown entire in Fig. 4.

FIG. 3.



The instrument in its entirety is simple in form and of neat symmetrical appearance. It is sufficiently light, weighing, filled, about eight ounces. It measures from tip to tip of hinges twelve inches. Its height, with tube down and stage in place, is four inches. Its greatest breadth is one and three quarters inch. The tube, with one sixteenth of an inch bore, should be at least eight inches in length. The base is more natural on a line with the tubes, but may be placed diagonally or transverse to them.

Uniformity in the instruments is attained by their careful construction upon a uniform plan, with chambers and passages of the same form and size, and using rubber membranes, basic and discous respectively, of the same thickness and quality, at the same tension, and glass tubes of the same bore; and then, to be quite sure of uniformity of action, graduating the tubes by an equal measure of liquid, and gauging the sweep of the levers by a method soon to be described. Instruments thus constructed and prepared may be depended upon to return uniform results in the tracings.

FIG. 5.

FIG. 6.

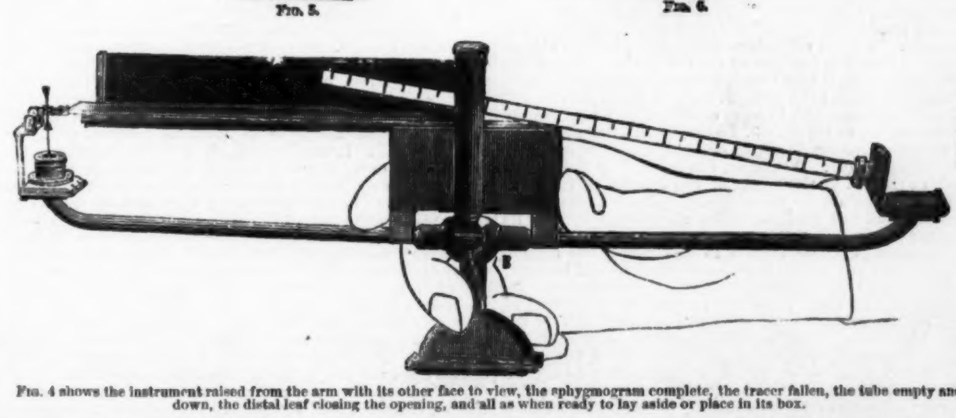


FIG. 4 shows the instrument raised from the arm with its other face to view, the sphygmogram complete, the tracer fallen, the tube empty and down, the distal leaf closing the opening, and all as when ready to lay aside or place in its box.

To prepare the Instrument for Use.—We first unscrew the base, fill it with liquid by immersing it in the same, and successively pressing and relaxing the membrane, or, which is more convenient, by means of a pipette, and, when full, screw it on again. We next fill the reservoir, leaving open the top, open the lids of the lateral cups, and holding the instrument free and level, and pressing gently with the finger the basic membrane so as to raise the liquid above the opening communicating with the reservoir, we turn on the liquid from the latter, which will traverse the lateral tubes and soon appear in the cups; removing at this point the finger from the membrane, we permit the cups to fill and overflow for a time. When quite sure that all air has escaped, we arrest the flow by a turn of the stopcock, and immediately thereafter shut down and secure the lids by their appropriate fastenings. We place the point of the pin in its socket, and press home the caps of the reservoir. The liquid now bulges slightly

the basic membrane, presses lightly against the under side of the disk-membrane, cupped a little by the weight of the lever—if the latter have been adjusted—and stands in the glass tube near the half-degree mark. If we stand the instrument by its own weight flat upon a smooth, even, hard surface, the liquid will rise in the tube about an inch and a half, marking, say, two degrees, and, as no tracings can be taken below this point, we begin here to estimate the pressure upon the artery. And in this we have a criterion by which we can always place and maintain the basic membrane at a proper and uniform tension. If, under the circumstances named, the liquid rises above this point, the membrane is too slack; on the other hand, if the liquid does not attain this point, the membrane is too tense. The correction can easily be made. The tracer is set by turning the delicate screw that traverses it so that when the instrument is held free and level, and the liquid in the tube stands at half a degree, it is raised upon the pin just above its rest upon the stage. The proper sweep is obtained as follows: with the instrument as above, we turn the stopcock, cutting off connection with the tube, and opening up the same with the disk, and then set it flat as before, on a smooth, level surface, and note the rise of the point of the lever. Making, say, one inch the criterion, it is easy to bring the sweep to this measure by the proper adjustment of distance between the point of the pin's impingement and the fulcrum. The tracer having thus been properly set, it will stand for all ordinary work without change. If we now turn the stopcock so as to cut off the disk-branch, and open up the tube-branch, the sphygmograph is ready to place upon the artery.

We must not omit to emphasize the point, that the interior must be kept full of liquid to the exclusion of all air, the inclusion of a single bubble of which will vitiate the action.

To Use the Sphygmograph.—We place the base accurately lengthwise over the artery, hold it steady and bear down gradually, keeping the eye in the mean time on the column in the tube. This will be seen to rise, pulsating as it rises. When the point of pressure is reached which yields the greatest sweep of oscillation, we reverse the stopcock, cutting off and holding this column *in situ*, and restoring connection between the liquid in the base and that in the opposite branch. Immediately this is done, the liquid in the tube stands at rest, and the tracing-lever is set in motion. The same force that caused the successive undulations in the tube is now turned upon the lever, causing its movements. Bearing steadily with the same pressure increased by just so much as will overcome the weight of the lever and establish the equilibrium between the basic and disk membranes, and so secure the greatest sweep of the tracer, and observing that the point of the latter just lightly touches the properly-smoked glass slide, we start the clock-work, and, as the stage is carried along, the tracing is obtained.

I have described the instrument as being held in place by the hand. This is undoubtedly the most natural and convenient method of using it. Any one with a steady hand and some experience with the instrument can obtain in this way tracings that are entirely satisfactory. At the same time, it is evident that the use and precision of the sphygmograph may be promoted by a suitable contrivance for steadily holding it in position on the arm. A light and easily adjustable pad and framework can be devised and constructed, which will answer the end in view.

When the instrument is being used daily, it may be kept constantly charged, and, in the intervals of non-use, all that is required is to turn down the tube and close the lateral cup by bringing down and fastening the opposite leaf. When it is not likely to be used for a time, it should be emptied of its contents, and put away with the passages all open. The filling and emptying are simple processes.

The Uses of the Tube.—In connection with the sphygmograph, there are three main uses of the tube: 1. It affords a free and convenient receptacle for the liquid displaced from the central cavity, as the instrument is pressed down on the artery. This provision allows the elastic membrane to embrace and press upon the artery so as to develop its proper tension, and establish the equilibrium between it and the artery—conditions requisite for the successful reflection of the pulsations. Again, this provision, in connection with the device for holding away the diverted liquid, insures the equilibrium of the small disk, and thereby the proper level of the tracer under all circumstances of different pressure required by different pulses. 2. By means of the tube, we readily set the instrument for the fullest tracing the given pulse will yield. The position of the base and degree of its pressure upon the artery which produce the highest undulation are very easily found, and, when found, the instrument is right for the tracing. This facility is in striking contrast with the delay and trouble one encounters in rightly placing the spring instrument. A great advantage too is, that after the sphygmograph is placed in position by the aid of the tube, and the stopcock is turned, it may be removed by accident or design, and it only requires to be brought back unchanged to its original place and pressure, to be in condition to make exactly the same tracing as before. 3. By the aid of the graduated tube we determine the degree of pressure upon and compressibility of the artery. Of course, the amount of liquid displaced, as marked by the height of the column in the tube, bears a direct ratio to the pressure of the basic membrane over the artery, and the point at which the column evolves its maximum of rise and fall marks the pressure which places the membrane in proper tension to best reflect the arterial pulsation. In a soft pulse the pressure required will be light, and the greatest undulation will be seen low in the tube. On the contrary, in a tense pulse the pressure required will be heavy, and the greatest undulation will be seen high in the tube. This index of compressibility and its variations is unerring as regards the pulse of a single individual, but, as regards the comparison of pulses of different persons, allowance must be made for the difference of relation which the artery sustains to the surrounding parts: Thus, a superficially-lying artery will display its maximum at a lower level, and a deep-lying one at a higher level, when both arteries are really of equal compressibility. But this same difficulty is encountered under all the devices hitherto employed for estimating this quality of the pulse; and the method in question, used with care and due allowance for the circumstances named, is eminently satisfactory, and indeed, I believe, the best yet proposed.

The Sphygmometer.—The above are the chief uses of the tube as related to the sphygmograph proper; but the graduated tube with its basic receptacle may be considered as a separate instrument, and constructed and used accordingly. (See Fig. 1.)

Obviously the sweep of the liquid in the tube caused by the pulsations will be in direct ratio to the smallness of the bore within the limits of free motion. The tube I have adopted is about one sixteenth of an inch bore, and gives an oscillation entirely sufficient. According to the amplitude of the pulses of healthy adults, the excursion varies in them from a little less than a quarter to a full half inch. In cardiac hypertrophy a full three quarters of an inch has been noted. In persons under fever without heart-affection a half inch will not unfrequently be exceeded. These undulations are perfect reflections of the pulse exhibited to the eye. By them we may read the pulse as follows:

The amplitude of the pulse is shown by the height of the undulations.

The regularity of the pulse is shown by the rhythmic succession and equal stages and development of the undulations.

The frequency of the pulse is shown by the rapidity of succession of the undulations.

The quickness of the pulse is shown by the suddenness of ascent of the undulations.

The compressibility of the pulse is shown by the degree of elevation at which is displayed the maximum amplitude of the undulations.

The tension of the pulse is shown by the mark of compressibility in connection with the rate and manner of descent of the undulations.

The dicrotous of the pulse is shown by the distinct break in the line of fall, or, as frequently seen, a second rise from the line of fall, or bottom, of the undulations.

The minor sphygmographic curves even are at times shown by the lesser interruptions in the fall of the undulations.

Thus all the qualities of the pulse revealed to the fingers are faithfully and beautifully shown to the eye, by the tube and its pulsating column; and, more than this, the additional peculiarities brought to light by the sphygmograph may here often be discerned by one who will carefully look for them.

Incidentally, as of some interest, it may be mentioned that the column may be viewed through a properly constructed magnifying-glass, and its undulations be seen in a magnified form; also, that the enlarged shadow of the undulations may be thrown upon a regularly moving screen, portraying there a correct though fleeting representation of the pulse, in imitation of the sphygmographic curves. Moreover, I can not refrain from expressing the idea that, if, by a suitable apparatus, this undulating column could be photographed in sharp outline upon a prepared surface moving at a regulated speed, we might have a very beautiful piece of mechanism, and a graphic delineation of the pulse equal, if not superior, to that by any other method. Is it too much to hope that mechanical ingenuity and the photographic art may yet supply the way and the means for this fine accomplishment?

The Cardiograph.—The instrument is adapted as it is for tracing the action of the heart's apex against the chest-wall. With the subject in the supine position, all that is required is, to place the base over the point of greatest impulse and press it down between the corresponding ribs, and proceed as in taking the arterial pulse.

But, to operate the instrument with the subject in the standing or sitting position, which is often best adapted for securing tracings of normal or feebly-acting hearts, it is essential to have the rest of the instrument horizontal, while the base is vertical. This is easily provided for by an elbow-tube, screwed in place between the base and stopcock.

With such a provision, when required, the conversion into a cardiograph is complete.

The question as to the best description of cardiac base has engaged my attention, but after experimenting with bases of different forms and sizes, I am quite satisfied that with none have I obtained results better than would have been made with the use simply of the arterial base.

A base (see Fig. 6) with a circular rim an inch and a half in diameter, is well adapted to cases of forcibly-acting heart, and to persons, as children, in whom the intercostal sulcus is shallow.

But the simple sphygmograph, with or without the elbow-tube, operates so satisfactorily as a cardiograph as scarcely to leave any thing to be desired. My plan is, to use it almost invariably with the subject lying down: I place it over the point of greatest impulse, which is usually between the fourth and fifth ribs, a little within the line of the nipple. The pulsations in the tube indicate, as in the case of the arterial pulse, when it is rightly placed; only the index of pressure is here of little if any value, and it is important to cut off the column at the lowest level where the undulations are fairly developed. As regards the undulations in the tube, these are exact reflections in form of the heart's action, and the instrument is hereby constituted a *cardiometer*.

After the column has been cut off and the pulsations turned to the tracer, any pressure or adaptation is employed that yields the freest motion to the latter. The tracings are better taken, according to my experience, while the subject is breathing naturally at the time; the cardiograph held in place by the hand, and all rising and falling with the respirations. Cardiograms so taken follow the line of the respiratory curves, but some, at least, of the cardiac evolutions are finely delineated, and the result altogether is more satisfactory than where the subject, by direction, holds his breath; for these tracings, slides of extra width are necessary.

As already implied, the new sphygmograph is a very convenient instrument. It is light in weight, small in bulk, portable. It need not easily get out of order; the membranes, even, if taken care of, will maintain their integrity for a considerable time, and when at last these show failure they can be readily replaced by new ones. It can be easily placed and retained in position. It needs no strapping to hold it in position; though, as before remarked, if from any cause a retaining apparatus should appear desirable, this can easily be provided. It is adapted to trace the pulsations of any of the superficial arteries; and, as a cardiograph, to trace the heart's pulsations with the same facility that it traces the arterial. As a sphygmometer, it displays the arterial pulse to the eye; as a cardiometer, it makes visible also the cardiac pulsations. Such is the facility of its employment that this entails upon the very feeble no uneasiness or annoyance, and the pulses of infants can without trouble be recorded by it. Indeed, if proved true, the practitioner, who is interested in precise methods of observation, may carry this instrument with him in his daily rounds, and use it to note the pulse, as with the thermometer he notes the bodily temperature.

Practical Uses of the New Instrument.—The applicability of the combined instrument to physiological research is markedly apparent; but we are not now prepared to appreciate the extent of its range of service in this field. That definite and rich results await it here, we have every reason to be assured. The facility and accuracy with which it traces the heart and the various accessible arteries eminently qualify the instrument for successful use in working out certain unsettled questions in the physiology of the circulation, whose determination would be a most important advance. In further estimation, the principle here utilized may evidently be extended and applied to other mechanisms and special uses besides those described. We shall presently see how, when the instrument is in action as a cardiograph, it will trace at the same time the respiratory movements, indicating in this that by a suitable modification there may be constructed on this principle a very perfect *pneumograph*. And so it readily occurs to one that adaptations and adjustments easily made will qualify the instrument for other distinct purposes; thus materially widening the field of its usefulness in the department of physiological study.

But that which concerns us most as practitioners is the adaptability of the instrument to the purposes of practical medicine. Into the merits of sphygmography in direct aid to diagnosis, prognosis, and treatment of disease, it is not my purpose now to enter; but I merely state my conviction that it is now in its infancy, with a sure future before it of development and extended usefulness. To the realization of this future the new sphygmograph with its evident advantages is doubtless well adapted to contribute.

It is admirably suited for experimentation upon the action of remedies as they affect the circulation. The liquid in the tube is first adjusted accurately at its correct level, and then the point of the fullest sweep of the undulations exactly ascertained and noted before turning the force upon the lever. The best tracing having been thus obtained, after marking the line of the base upon the arm, the instrument is removed and the stopcock turned so as to let the liquid back into the central chamber. The drug is now administered, and, after sufficient time for its effects, the instrument is taken up, the liquid readjusted, and then placed upon the arm in precisely the same situation as before, the arm being, too, in exactly the same position, and pressed down until the liquid measures the same height as at first, and the best tracing again taken. A third is also taken at the measure now of the fullest sweep of the liquid. The three tracings with their pressure-marks are compared. Cardiac tracings may also be taken, one before and one during the action of the remedy, but evidently the pressure-gauge will not have the significance here that it has in relation to the arterial tracings. By careful procedure in this way, results may be obtained important in themselves, and which will illustrate and prove the value of the instrument in this branch of investigation.

PROCEEDINGS OF SOCIETIES.

ENTOMOLOGICAL SOCIETY, LONDON, JANUARY 5.

SIR SIDNEY SMITH SAUNDERS, C.M.G., President, in the Chair.—The Rev R. P. Murray exhibited a collection of Lepidoptera taken by himself on the Higher Alps, among which were some interesting mountain varieties. Mr. S. Stevens exhibited a specimen of a dragon-fly rare in this country (*Aeschnia mixta*), which he had picked up nearly dead in his garden at Upper Norwood in the middle of November. Mr. Champion exhibited some rare Coleoptera recently taken by himself. Mr. H. W. Bates communicated a paper entitled "Additions to the List of Geodephagous Coleoptera of Japan, with synonymic and other remarks." Mr. W. H. Miskin, of Queensland, communicated a description of a new and remarkable species of moth belonging to the genus *Attacus*, of which a male and a female had been taken in the neighborhood of Cape York. He had named the species *A. Hercules*. The expanse of the wings measured nine inches, and the hind wings were furnished with tails. The specimens had been deposited in the Queensland Museum. Mr. C. O. Waterhouse forwarded a paper "On Various New Genera and Species of Coleoptera," belonging to the *Geodephaga*, *Necrophaga*, *Lamellicornia*, and *Rhyncophora*.

AFRICAN EXPLORATION.

ROYAL GEOGRAPHICAL SOCIETY, January 11. The President, Major-General Sir Henry Rawlinson, K.C.B., opened the proceedings by congratulating the Society on the recent successful journey of Lieutenant Cameron across the entire breadth of the African continent. After referring to the circumstances under which he had first proceeded to relieve Livingstone, and, after the death of the latter, had explored Lake Tanganyika and discovered its outlet, Sir H. Rawlinson stated that Lieutenant Cameron had not succeeded in following the course of the Lualaba down to the coast, but that he had fairly crossed the continent of Africa, traversing 1200 miles of entirely new country, and had taken nearly 400 lunar observations, thus laying down a sound geographical basis for the future exploration of the country.

Letters from Lieut. Cameron were then read, in the first of which he stated that he was recovering from an attack of scurvy, which came on the day he arrived at the coast. He pronounces the interior of Africa to be a magnificent and healthy country of unspeakable richness. Coal of good quality had been found, and gold, copper, iron, and silver are abundant. The lieutenant is confident that with a wise and liberal expenditure of capital, one of the greatest systems of inland navigation in the world might there be opened and soon prove remunerative. Among the vegetable productions which may be made profitable are nutmegs, coffee, semsem, ground-nuts, oil-palms, the *mpafu* (an oil-producing tree), rice, india-rubber, copal, and sugar-cane. It would be possible to connect by a short canal the two great systems of the Congo and Zambesi.

In the second letter, Lieutenant Cameron stated that from Ujiji he had travelled to Nyangwe, Livingstone's furthest point, by nearly the same route as the Doctor had followed. Thence the Lualaba river is reported to leave its northing and turn to the west, and further down to flow in a W.S.W. direction. A river said to be as large as the Lualaba at Nyangwe joins it a short way further down from the northward, besides other important rivers from the same direction. At Nyangwe the Lualaba is 1400 feet above the sea, and lies in the centre of an enormously wide valley, which receives the drainage of all this part of Africa. After describing his route from Nyangwe and the difficulties raised by the various chiefs against his progress, Lieutenant Cameron gave a sketch of the geography of the region, from which it appears that the Lomami, which is a tributary of the Lualaba, has no connection with the Kassabe, as shown by Keith Johnston. The Lualaba mentioned as such by the Pombeiros was the true Lualaba. Between Lufira and the true Lualaba, lies Katanga, a district rich in copper and gold, and with a great abundance of game. The Lukuga or outlet of Lake Tanganyika joins the Lualaba before reaching Lake Lanji, and beyond Nyangwe the Lualaba flows through Lake Sankorra.

After some geographical notes on the results of Cameron's journey by Mr. Keith Johnston had been read, a discussion ensued in which Mr. Monteiro, Mr. F. Galton, F.R.S., and the Rev. Horace Waller took part.

The President said, that it would be interesting to know that Lieutenant Cameron had travelled on foot 2953 miles from Zanzibar to Benguela, trusting to mere accident for his livelihood as he went along. He also announced that the Royal Geographical Society had contributed 1000*l.* towards the heavy expense incurred through Cameron's expedition.

THE ROYAL SOCIETY.

HONOR TO DR. HOFMANN.

In presenting the Copley Medal to Dr. Hofmann at the Anniversary Meeting of the Royal Society, November 30th, 1875, Dr. Hooker, the President, said:

"The Copley Medal has been awarded to Professor August Wilhelm Hofmann, F.R.S., of Berlin, for his numerous contributions to the science of chemistry, and especially for his researches on the derivatives of ammonia.

"The researches of Dr. A. W. Hofmann, from first to last, are related by a strict logical connection, from which (although in various side-paths he has made truly interesting discoveries) he has never essentially deviated. Indeed these researches may be considered as constituting one great and prolonged research on the organic bases theoretically and experimentally considered. It is not, however, to be imagined that because, to a certain extent, limited in its range, this work is of a special or technical order. The subject covers a large area, and is calculated to lead the investigator to the consideration of the most important chemical problems.

"The memoirs of Dr. Hofmann in reference to the organic bases fall under several heads: (1) The researches on aniline and the organic bases contained in coal-tar. These researches are mainly included in the period between 1843 and 1850. (2) The investigations on the molecular constitution of the organic bases derived by the substitution of the alcohol radicals in the molecule of ammonia (1850–51). (3) The phosphorus bases and the diatomic ammonias (1857–60). (4) The investigations on rosaniline and the various coloring-matters derived from coal-tar (1860–70).

"In the course of the aniline investigations, Hofmann made an important contribution to the unitary theory of chemistry. Dumas had shown that the essential chemical properties of acetic acid were not altered by the substitution in the acid-molecule of chlorine for hydrogen; but no organic base had yet been discovered derived from another base by a similar process. Fritsche, indeed, had made a bromine derivation of aniline, in which three atoms of hydrogen were replaced by bromine; but the substance thus formed was a neutral (not basic) body. It occurred to Hofmann that the substitution had here gone too far, and that for this reason the basic properties of aniline had disappeared. Consequently, by an ingenious process (devised for the experiment), the treatment of chlorisatin by the hydrate of potash, he prepared mono-chlor-aniline—aniline, that is, in which one atom of hydrogen was replaced by chlorine. This body was a base, like aniline itself. Hofmann established its basic character by the preparation of many of its salts (*Liebig's Annalen*, vol. liii., p. 1, 1845).

"At the date when Hofmann's paper on the molecular constitution of the volatile organic bases was presented to the Royal Society (December 1849), Wurtz had just prepared, by a striking experiment, the primary monamines of the alcohol radicals—that is, a system of bases in which one third of the hydrogen of the ammonia was replaced by the hydrocarbon, the existence of which (it may be noticed) had been predicted by Liebig as a consequence of his views as to the composition of the organic bases. The experiments of Hofmann were in the same direction as those of Wurtz, but of far more general application. By the action of the iodides of the alcohol radicals upon ammonia, Hofmann replaced successively the three atoms of hydrogen which its molecule contains by these hydrocarbons—a method fraught with important results, both theoretical and practical, with which all chemists are familiar.

"Among other consequences, this method placed the theory of types on a solid experimental foundation, which served as the basis of its future development. A critical test was given by which the constitution of any given 'ammonia' could be ascertained, the number of derivatives of the 'ammonia' when subjected to the action of iodide of ethyl corresponding to the number of atoms of hydrogen which is still retained unreplaced by hydrocarbon. Hofmann applied this test to aniline, and demonstrated, by the successive formation of ethyl-aniline and diethyl-aniline, that this base belonged to the primary monamine class, containing two atoms of hydrogen unreplaced by hydrocarbon. To trace out, however slightly, the consequences of this method would be a serious task indeed. It is sufficient to say that the views at present held by chemists as to the molecular constitution of water, according to which water is regarded, like ammonia, as a typical molecule, but containing two atoms of hydrogen (instead of, as in the other case, three) replaceable by the alcohol radicals, are based upon experimental evidence for which the very same instrument of research, the iodide of ethyl, and methods in all respects analogous to those by which Hofmann thus established the constitution of aniline, were employed.

"According to these views, triethyl-aniline represented ammonia in which all possible substitutions of this order had been effected. However, Hofmann applied his test to this substance, and obtained a most remarkable result. A molecule of iodide of ethyl combines with a molecule of this substance, giving rise to the iodide of a molecular group, behaving like potassium or sodium, 'a true organic metal in all its bearings.' The ground of this assertion is, that this iodide of tetrethyl-ammonium, when treated with freshly precipitated oxide of silver, is decomposed with the formation of an oxide of the 'organic metal' possessing the main features of potash. This train of investigation has not as yet been adequately pursued; but the fundamental importance of this experiment, in reference to our knowledge of the elemental bodies, can not be doubted.

"The first memoir on the phosphorus bases, in which the existence of a class of phosphorus bases analogous to the compound ammonias was experimentally established, was published in conjunction with M. Cahours. In three subsequent memoirs these compounds were further investigated with the determination of the differences by which they were discriminated from their nitrogen analogues. We have here presented to us the first example of a diatomic base formed by the action of bromide of ethylene or triethyl-phosphine, in which reaction (as in the similar case of the diatomic alcohols) Hofmann successfully established the formation of an intermediate monatomic bromide, the reaction taking place by two distinct stages. In the third of these memoirs a new class of compound bases is brought before us, containing both nitrogen and phosphorus. Subsequently, in a series of somewhat less elaborate memoirs, the conception of the typical character of ammonia is greatly expanded by the examination of the derivatives of two and three molecules of ammonia.

"As to the researches in reference to the coloring-matter derived from coal-tar, it is only necessary to observe that his inquiries initiated and rendered possible what is now a vast branch of industry. In reference to rosaniline itself (the key of the system), he established the fact, long unknown, that this substance was not an aniline compound at all, but derived from the combination of aniline with toluidine.

"I may lastly mention, as a fitting conclusion to this series of discoveries, an investigation of very wide interest, which has resulted in the construction of the normal cyanides (*a*) of the monatomic hydrocarbons, formed by the action of chloroform on the primary monamines, which, together with water, are resolved into formic acid and the base whence they are derived; while their isomers (class B), the nitrites, under similar conditions, yield ammonia and their corresponding acids. Hofmann has also established the existence of a new class of cyanates (β) of the same monatomic hydrocarbons which, together with water, are resolved into ammonia and their corresponding alcohols, the original class (*a*) being resolved under the same circumstances into carbonic acid and the primary monamines, as in the experiment of Wurtz before referred to, the whole investigation standing in intimate connection with Hofmann's previous work.

"To estimate the value of these results, it is necessary to go through the vast mass of experimental evidence from which they are deduced, which constitutes a body of complete and exact information in reference to one general subject not easily paralleled in the history of chemistry."

THE FRENCH ACADEMY AWARD OF PRIZES.

At the anniversary meeting of the Paris Academy of Sciences, on December 23d, the following prizes were awarded as the result of the competition for 1875:

1. Grand prize in the Mathematical Sciences, not awarded, and the subject re-set for competition in 1878—"Investigation of the elasticity of crystalline bodies from the double point of view of experiment and theory."

2. Grand prize in the Physical Sciences. The subject was, "To investigate the changes which take place in the internal organs of insects during complete metamorphoses." The prize was awarded to M. Künckel, Assistant-Naturalist at the Paris Museum.

3. The Poncelet prize, to M. Darboux, for his analytical and geometrical works.

4. The Montyon prize in Mechanics, not awarded.

5. The Plumey prize of 2500 francs was awarded to M. Madamet, French naval engineer, for an apparatus invented by him to indicate at any moment the number of turns made by a marine steam-engine by the simple inspection of a dial, and without the need of employing a watch.

6. Fourneyron prize of 1000 francs, to M. Sagebien.

7. The Lalande prize in Astronomy, to M. Perrotin, of the Toulouse Observatory, for his astronomical work generally, but specially for his discoveries of small planets.

8. The Lacaze prize in Physics, 10,000 francs, to Professor Mascart, for his researches on the solar spectrum, on the measure of the dispersion of gases, on the influence which the motion of the earth has on optical phenomena, and for his investigation of the rate of light.

9. Montyon prize in Statistics, to M. Borius.

10. The Jecker prize of 5000 francs awarded to M. Edouard Grimaux for numerous researches in Chemistry, more especially in chemical synthesis.

11. The Lacaze prize in Chemistry, 10,000 francs, to M. Favre, Dean of the Faculty of Sciences of Marseilles, for his great work on the transformation and equivalence of chemical, physical, and mechanical forces. It was while pursuing his researches in thermo-chemistry, commenced thirty years ago in conjunction with Silbermann, that M. Favre was led to investigate the great question of the equivalence of work effected by forces of different origin. M. Favre, giving an experimental demonstration of the most ingenious of Joule's views, made use of his mercury calorimeter, in the form of a thermometer in whose reservoir may be placed one or more elements. He thus established that the heat developed by resistance to the passage of electricity in the conductors of a simple voltaic couple, is simply borrowed from the total heat due to the chemical action which engenders the current; if this resistance to the passage of electricity be annulled, we obtain, as the work of the pile with closed circuit, the quantity of heat which will be due to chemical action alone without the transmitted electricity.

12. The Barbier prize in Medicine, to Professor Rigaud.

13. The Desmazières prize divided between M. Eugène Fournier, author of two memoirs on the Ferns of Mexico and of New-Caledonia, and M. Emile Bescherelle, author of two memoirs on the Mosses of the same countries.

Prizes 14, 15, and 16 not awarded.

17. Grand prize in Medicine and Surgery, to M. Onimus.

18. Montyon prize in Medicine and Surgery. These prizes, of 2500 francs each, were awarded to M. Alph. Guérin, M. Le Fouest, and M. Magitot respectively. "Encouragements" of 1500 francs each were awarded to M. Berrier-Fontaine, to M. Pauly, and to M. Raphael Veyssière.

19. The Bréant prize not awarded.

20. The Godard prize in Medicine, awarded to M. Alph. Hergott.

21. The Serres prize not awarded; but a reward of 3000 francs was given (1) to M. Campana for his researches on the anatomy and physiology of the respiratory and digestive apparatus, and of the serous membranes of birds; and (2) to M. Georges Pouchet for a MS. work on the development of the skeleton, and especially the cephalic skeleton of osseous fishes compared with that of some other vertebrates.

22. The Chaussier prize in Medicine, of 10,000 francs, divided between M. Gubler, M. Le Grand du Saulle, MM. Bergeron and l'Hote, and M. Manuel.

23. The Montyon prize in Experimental Physiology, 764 francs, to M. Faivre, Dean of the Faculty of Sciences of Lyon, for his researches on the functions of various parts of the nervous system of insects. M. Faivre has established that among insects the localization of function and the division of physiological work are carried further than is generally supposed.

24. The Lacaze prize in Physiology, 10,000 francs, awarded to M. Chauveau, Director of the Veterinary School of Lyon, for his researches on virulent and contagious diseases. M. Chauveau has proved that the virulent activity of the vaccinal, variolar, and glanderous virus is not due to the liquid, as a whole, but oftenest to corpuscles which are held in suspension. M. Chauveau has, moreover, discovered that the agents of contagion have not only as a vehicle the liquids which come from the bodies of the sick, but that they may be transmitted to healthy animals by means of air and water. He shows that the human variola is a distinct malady by itself, of which the primary source is the organism of the horse.

25. Montyon prize, in connection with unhealthy occupation, 2500 francs, to M. Denayrouse for his invention to protect workmen while in the midst of an irrespirable medium.

26. The Tremont prize, 1000 francs, having been awarded for three years, 1873–75, to Professor A. Cazin, an "encouragement" of 500 francs was awarded to M. Sidot for his researches on the various conditions of carbon and on the protosulphuret of carbon.

27. The Gegner prize of 4000 francs was awarded to M. Gaugain to assist him in pursuing his researches on electricity and magnetism.

28. The Laplace prize, consisting of a complete collection of the works of Laplace, was awarded to M. Bonnefoy, "dux" of the École Polytechnique in 1875.

[California Spirit of the Times.]

THE SNOW-PLOUGHS OF THE CENTRAL PACIFIC RAILROAD.

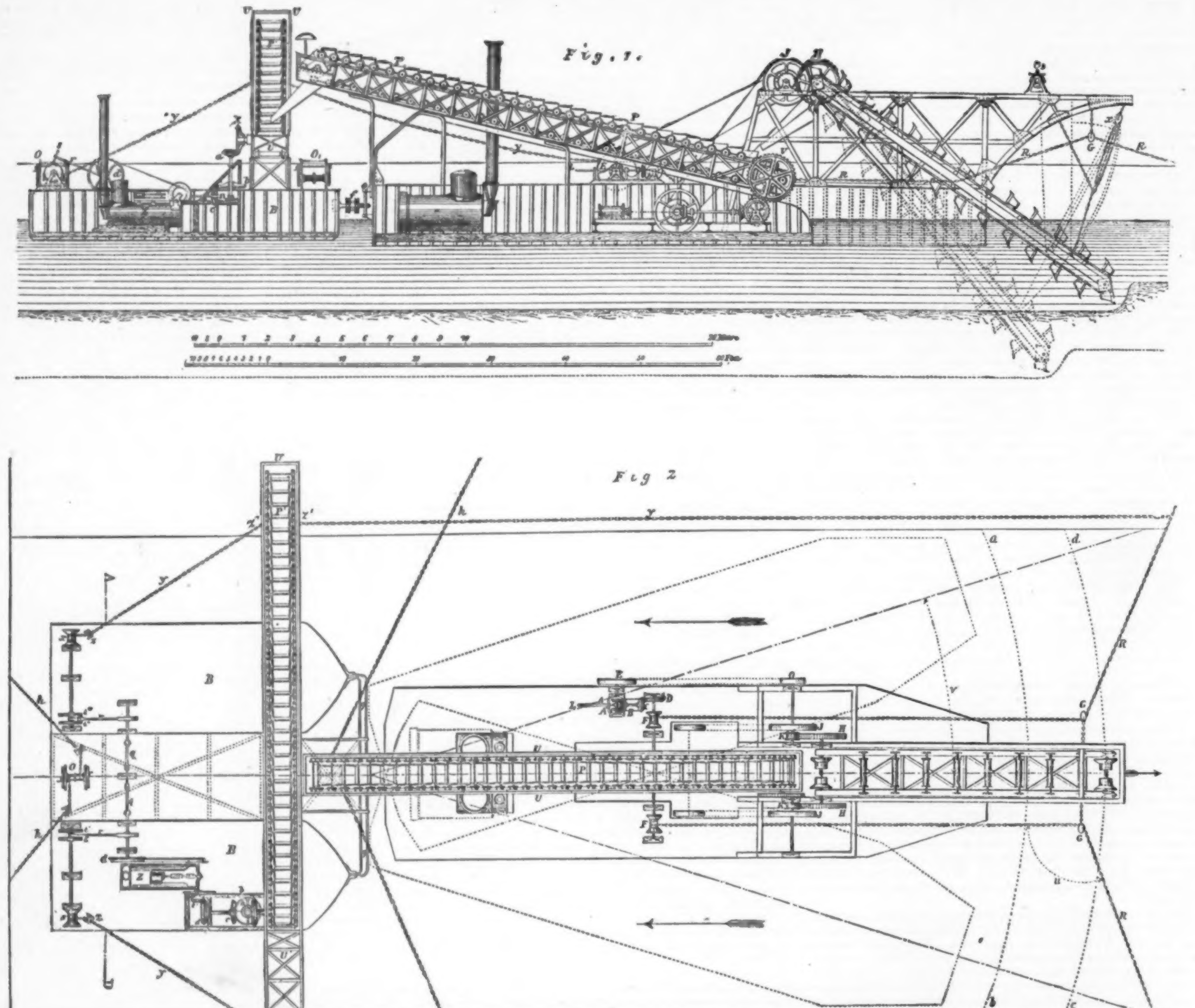
Our illustration is an example of the snow-ploughs used by the Central Pacific Railroad Company, during the winter months, for the purpose of keeping the road open and the tracks clear. All are of similar construction.

The plough is 13 feet 4 inches high, 10 feet 6 inches wide, and 28 feet long, with an apron 16 inches wide, making total length over all 29 feet 7 inches; 6000 feet of lumber, 10,000 lbs. wrought and 6000 lbs. cast-iron were used in the construction. Total weight as it stands on the track, 37,950 lbs. The plough has two trucks. The forward truck has 4-29 inch wheels, 1½ x 3 inch truss bars, 4½ inch axle, 3¾ x 5½ inch bearings, with a solid oak truck frame 12 x 14 inches. The back truck has 4-33 inch wheels, with truss bars and axle same size as the forward truck. It has two truck frames 6 x 12 inches. The bottom frame is trussed with two 1¼ inch rods; between these frames, and as near the centre as possible, are three rubber springs 8 inches in diameter, 3 inches high, thus making the truck centre-bearing, and enabling the plough to adapt itself to rough as well as smooth track.

The body of the plough is constructed of Puget Sound lumber, with furrow-board covered with white ash, polished, to preventing the snow from adhering. The front or furrow-board runs back on an angle of 31 deg. for 16 feet, and up in half circle 19 inches radius.

The apron is made of two pieces of ⅜-inch boiler-iron riveted together, and has two steel shoes; it is hung to the plough with six heavy strap hinges. The steel shoes rest on the rail, and are held there by two iron clamps 3 feet long, which are held in the centre by jaw-bolts. One end of the clamps rests on the lower edge of the apron, the other end on a 3-inch rubber spring inserted in the furrow-board 20 inches from the point of the plough, thus preventing the apron from being thrown back when it comes in contact with ice. The company has eight ploughs of this class. Five are stationed on the Sierra Nevada Mountains, two on the Pequod and one on Promontory Mountain.

To witness one of these snow-ploughs in action, driven along by fourteen of the largest-sized locomotives used by the company, is as grand a sight as one would wish to look at as showing the power of steam and man's inventive genius. We saw this branch of the tremendous strength and efficacy of the machinery of the railroad during a winter's storm, and we shall never forget the impression made. We were one of a party "snowed in," and we occupied a position where we could see every movement. Our excitement and interest at the time return as we refer to it. With a thundering motion that causes the earth to shake and tremble, and with the screeching of the engines by which the plough is driven, in unison, it dashes up to and attempts to make the curve. Here the snow is piled up as high as the plough, which is just small enough to go through the tunnels, which are nineteen feet in height and twenty in width, and though driven by the force of fourteen first class engines, with all the steam on that they can safely bear, and coming head on, the contending mass does not give way an iota. Here, indeed, is a contest between Titans. How the engines struggle and strain and bend to the work! Are they thus to be thwarted? See how they puff and breathe, and try to break down the barrier that impedes their power and might! The lookers-on watch every motion and struggle of these panting monsters. Their sympathy is enlisted to the fullest extent. How we wish we could aid in the undertaking. See their breath as it passes through the funnel, the mouth of their being. Again the whistles shriek as if in agony at the terrible strain which the iron muscles, ribs, and arms of their bodies is being put to. Oh! for one more trial, and that a successful one! What is that sound? The warning whistle to back down? Surely the grand battle is not thus to be lost. Oh! no; we will all lend a helping hand rather than see the undertaking fail. No, no! the contest is not yet over. Our party look on in death-like silence. See! see! there is the smoke. Faster and faster it comes; now the whistles again give forth their battle-cry in unison; and like the rush of the whirlwind comes the great engine of this war. Now it comes with a crash against the battlements of snow. The great mass moves, crumbles, and writhes under the pressure; the plough advances; put on more power; another struggle and victory will crown the effort. What! does it not yield? Bring on the reserve, then, and let us see who will triumph. No, that must not be; let the simple lesson of the spider impress us now. Let us try again, we may yet win. Come, rally all of you—don't look so disappointed; we are not beaten, only received a temporary check. Our Grand Commander is not thus to be thwarted. The order is given to withdraw for recuperation; the army of iron will, strength, and endurance retires to a point half a mile below, and prepares for another encounter. In breathless anxiety is every sound and motion noted. The point is reached; the stragglers are all drawn in, and the blast of preparation and advance is again resounding on the air. Should this not rout the enemy, we determine to capitulate. Now comes the trembling of the earth, the rushing sound, the fierce battle-cry, the increase of strength as the approach is made to the foe. Ah! shriek in your loudest tones—the shock is coming; another moment and the blow is delivered; resistance is attempted, but onward these mountain monsters press towards the heart of the enemy. Ah! it is yielding—open your valves—drive on—drive on—a check! again advance, then. Is that an opening in the fortifications? Yes, yes. Another such trial will conquer—it has been made; put on all your power—the works are moving! Keep on, don't give way now; a little more and you will capture the whole of it. It is done!—the mighty avalanche is torn into atoms; right through it they dash with impetuous speed, and throw up, ten feet higher than the plough, huge masses of the white and pure soil, leaving us the witnesses of a sight that has no parallel anywhere. It is not to be wondered that those who were assembled in sight of this contest broke out with cheer upon cheer, waved handkerchiefs, and gave play to every demonstration of delight as the locomotives whirled past where they stood, never slacking their speed until reaching a point half a mile above us, and cutting through the snow and cleaning the track as if done with a knife. It was, without exception, one of the grandest sights we ever saw, and of itself was well worthy even such a journey as we had undertaken, to see.



DREDGING MACHINERY FOR LAKE FUCINO.—BY M. A. BRISSE, ENGINEER.—(*See page* 121.)

[Engineering.]

THE DRAINAGE OF LAKE FUCINO.

LAKE FUCINO, situated about 55 miles to the east and a little to the north of Rome, has an area of about 61.6 square miles, and an altitude above the sea of 2296 feet. At an early geological period its extent was nearly double, and its water overflowed towards the northwest, above the level of the Campi Palentini, and fell into the river Salto, and ultimately to the Tiber. But at a more recent epoch the water flowing into it diminished, and the only escape was by evaporation. According to the dryness or wetness of the season, the level of the lake receded or overflowed, flooding the surrounding district, the difference between high and low levels being at least 52 feet. The ancient towns of Marruvium and Penna were, it is said, destroyed by these inundations. The Romans, desiring to prevent such catastrophes and reclaim so large a tract of cultivable land, set themselves to drain the lake, and they availed themselves of the stream Liri, an affluent of the Garigliano, to carry off the water of the lake. In the reign of the Emperor Claudius, 30,000 slaves were employed during eleven years to pierce a tunnel 18,500 feet long through the Monte Salviano, which separates the lake from the valley of the Loire; the section of the tunnel was, however, too small, and the drainage was only imperfectly effected. In the thirteenth century efforts were made to restore this tunnel, which had fallen into decay, and again in 1855, which has now been practically completed, thanks to the energy and capital of the Prince Torlonia. The following is a comparison between the ancient tunnel and the new discharge channel:

	Ancient Tunnel.	New Channel.
Length	18,500 feet.	20,678 feet.
Average cross-section	106 sq. feet.	212 sq. feet.
Cost	9,880,000*l*.	1,200,000*l*.

In 1855 a public company, in which the Prince Torlonia was the largest shareholder, was formed, to restore, if possible, the ancient works, and the undertaking was intrusted to M. de Montricher, a French engineer of repute. It was found, however, that the old works were in too dilapidated a condition to be restored, and after many efforts, the scheme would have been abandoned had not the Prince Torlonia assumed the whole responsibility, and resumed the works at his own cost. Since then they have been carried on, the total outlay having exceeded two millions sterling, and in a short time it is hoped that this expenditure will become remunerative. The waters from the lake will be discharged through a syphon 1500 yards in length, delivering about 250 cubic feet per second. The water will be brought to the syphon by means of an extensive *réseau* of canals, employed to drain the area, and it is in the construction of these canals that the dredging machinery we illustrate has been constructed.

The dredging machines employed for opening the canal to drain the lake differ chiefly from ordinary types by the circular movement given to the fore part of the vessel which carries the train of buckets, and by the system of transporting the material excavated. In this circular movement the forward part of the vessel being successively drawn from one side of the river to the other, by the chains R R, Fig. 2, the lower part of the chain of buckets describes an arc *c d*, a movement executed alternately from right to left, and from left to right, and to such an extent that the chord of the arc is equal to the width of the canal. In this circular movement the vessel turns around a vertical axis *e*, Fig. 1, fixed at the stern. This axis passes through a hinge, carried on a carriage *f*, running on rails *g* attached to the forward ends of the two barges B B, Figs. 2 and 4, which are firmly connected together. These barges are securely anchored to both sides of the canal by four chains h h h^1 h^1, controlled by the winches Ω and $Ω_1$ presectively.

The carriage *f*, which is shown to a large scale in Figs. 12 and 13, is composed of eight double-flanged wheels, running on a frame and embracing the bar *g* on each side. From the middle of the frame projects a horizontal bracket *j*, on which are mounted two pulleys, with semicircular grooves, and running free on their axes. As arranged they embrace closely the vertical shaft *e*. The movement of these pulleys, and the arrangement of the carriage, allow the axis *e* attached to the dredge to adapt itself with facility to the various motions given to it in the course of the work.

It may be remarked here that the width and depth of canal being given, the size of the apparatus, whenever practicable, should be adjusted to the size of the work in such a manner that the axis *e* should always remain in the centre-line of the work, and the whole width can thus be dealt with continuously.

The circular motion on the forward part of the dredge is transferred by the engine to the pulley E, Figs. 2 and 7. The shaft on which this pulley is mounted carries two loose bevel pinions A A^1, each formed with a sleeve, as shown, and being loose on the shaft N, which is thus free to run without moving the pulleys, which can not shift laterally on account of the sleeves that enter the bearings in the bracket p p^1. The pinions gear into the bevel-wheel B, which is fast on its shaft, the other end of which carries a pinion *c*, gearing into the wheel D. On this latter are the drums F F, placed, one on the right the other on the left of the dredge, and around them are laid the chains R R, which then pass to the guiding-pulleys G G, and afterwards to the banks of the canal where they are fixed. This mechanism is put in motion either backwards or forwards by the clutch on the shaft N, worked by the lever L. The forward motion of the dredge is effected by means of mechanism placed at the end of the two barges B B. The principal parts of this mechanism consist of a jointed shaft *q*, Fig. 2, the eccentrics *r r* on the shaft, two levers *s s*, Fig. 4, in connection with the eccentrics. These levers are each placed between two ratchet-wheels *t t*, Fig. 6, and turn freely on their respective shafts. Each carries at its upper part two driving-ratchets u u^1, by which either of the wheels of both groups can be put in motion. Below are placed the stops v v^1, which stop the wheels at any point where they are placed by the driving-ratchets. Lastly, two drums *x x* are placed on the shafts of wheels *t t*; over these drums are placed the chains *y y*, guided by the rollers *z z* placed along the sides of the canal where they are moored. A pulley *d* placed on the shaft *q* receives motion by a strap from a portable engine placed in the barge B. Whilst the dredging apparatus is making its sweep across the canal, this mechanism is at rest, and at the moment when the direction of this is changed, it is placed in motion by means of the driving ratchets, and the dredge is propelled forward into the position for another sweep. The signal for this forward motion is given by a bell placed at the upper end of the lattice girder by which the material excavated is removed, this bell being controlled by a cad under the hand of the workman in charge of the lever L. In going forward the winch Ω slackens the chain *h h*, while the winch $Ω_1$ hauls on the chains h^1 h^1.

The buckets empty their contents on an endless chain P, composed of articulated receivers, and placed in the longitudinal axis of the dredge, Figs. 1, 2, and 3. This chain is moved by the drums T T^1, placed at the ends of a lattice girder U, on which are laid the iron rails, one above and one below, for the endless chain to travel upon. The lower drum T is driven by the wheel V, mounted on its shaft, and to which motion is imparted from the engine. The endless chain of receivers empties the material excavated on to a similar chain P^1, placed like the former on a lattice girder U^1, and carried by the two barges B B, Figs. 1, 2, and 3. This chain situated at right angles to the axis of the canal, empties the material into wagons on a railway laid on the bank: the chain is moved by the wheel X on the lower drum shaft, and driven by the portable engine Z. The lattice girder U^1, carrying the chain P^1, is of the form shown in Fig. 3. This arrangement was adopted so that the excavated material could be discharged on to the canal bank when the water level fell below the ground level on each side. The arrangement and construction of the endless chain are shown in Fig. 5, and that of the buckets in Figs. 8, 9, 10, and 11.

The following results were obtained per day of ten hours: The speed at which the machine is driven is equal to 17 buckets per minute, and the buckets are of such a capacity (about 5.25 cubic feet) that the total amount excavated is about 2000 cubic yards; allowing 33 per cent for loss, which is excessive, the effective work per day of ten hours is 1330 cubic yards.

The circular motion of the dredging machine was suggested by the results obtained by a previous apparatus employed for cutting out trenches to form the canal. To make a series of excavations which together should form the width desired, would have been a long and very costly operation. Such a method might have been followed when the material to be removed is soft enough to fall immediately into the spaces left by the buckets as they work, but it is otherwise when it is so hard as is the case at the Fucino works. It will be understood that under the first-named conditions the trenches made formed small canals, in which the buckets passed to and fro, doing no work for a large part of the time. There remained, moreover, on a number of points, and between the trenches, a portion not excavated at all, so that the difficulties in dredging out the next width were increased. All these drawbacks were removed by the adoption of the system illustrated. The buckets are always at work upon a regular bed, the canal is opened out continuously for its full width, the bottom is well formed, and with proper care the work done by the machine is extremely regular. The only time lost is in shifting its position by means of the chains as described. The cost of excavation was found to be almost .81 pence per cubic yard.

With reference to the extremely small cost of dredging at the Lake Fucino—.81 pence per cubic yard of material lifted—we give below M. Brisse's detailed figures by which he arrives at this sum. It will be noticed that the cost of labor is unusually low.

The following is an abstract of the detailed cost of raising by the dredging machine an average of 1330 cubic yards of material per day of ten hours:

	s.
Wood fuel for 40-horse power engine, burning 15.4 lb. per horse-power per hour	44.85
Lubrication, packing, waste, etc.	3.65
Wages of eleven men, including two employed in adjusting the anchorages on the banks	25.25
Maintenance of machine	16.00
Total per day	89.75

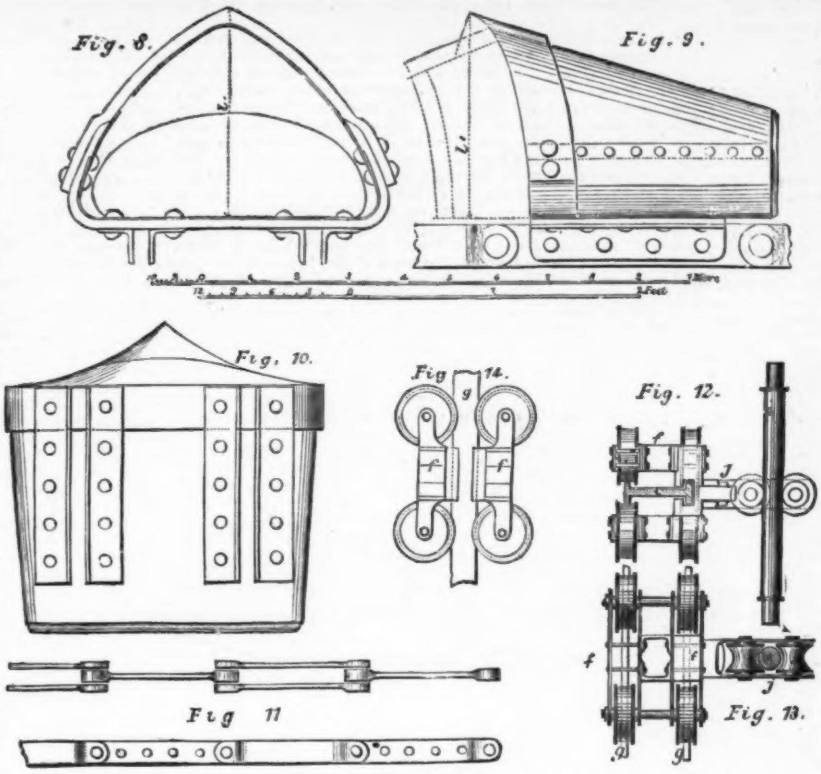
$\frac{89.75}{1330} = .81$ pence per cubic yard.

As to the cost of depositing the material excavated into wagons on the banks, the following data are given by M. Brisse:

	s.
Fuel for 10-horse engine, burning 15.4 lb. of wood per horse-power per hour	11.2
Lubrication, packing, waste, etc.	1.0
Wages of ten men	18.0
Maintenance of plant	8.0
Total cost per day	38.2

or per cubic yard of material transported $\frac{38.2}{1330} = .34d.$

This gives a total cost of 1.15 pence per cubic yard for dredging, raising the excavation to a height of 29 ft. 6 in., and depositing it on the banks.



DETAILS OF DREDGER FOR LAKE FUCINO.
DESIGNED BY M. A. BRISSE, ENGINEER.

SNOW-PLOUGH ON THE CENTRAL PACIFIC RAILROAD.—(*See page* 119.)

THE Minnesota Senate has voted to appropriate $10,000 to the Centennial Exhibition. The State Editorial Convention urged an increase to $30,000. The space allotted to Minnesota in the National Hall is full, and her building can not be constructed without an increased appropriation.

[Popular Science Review.]

THE INFLEXIBLE AND HER ARMAMENT.

By A. Hilliard Atteridge.

The old type of man-of-war is now fast becoming a thing of the past. The splendid three-deckers and swift-sailing frigates that carried our flag to victory in the days of Jarvis and Nelson, or that only twenty years ago engaged the sea-forts of Sebastopol and blockaded the Baltic shores of Russia, will soon be as obsolete as the triremes of ancient Rome and the "tall galleons" of the times of the Armada. Already they have disappeared from the line of battle, and are relegated to the humble position of guard-ships at our home ports or cruisers on distant stations, where their most serious enterprises are the bombardment of a village, or the capture of a slaver. One by one they are condemned and broken up, and no new ships are laid down to replace them; and already we can anticipate the time when, perhaps, the sole representative of the grand old floating fortresses that once formed our great unarmored fleet will be Nelson's ship, the Victory, lying at her moorings in Portsmouth harbor like some war-worn veteran of Greenwich or Chelsea whose fighting days are over, and who is spending his old age in honorable retirement.

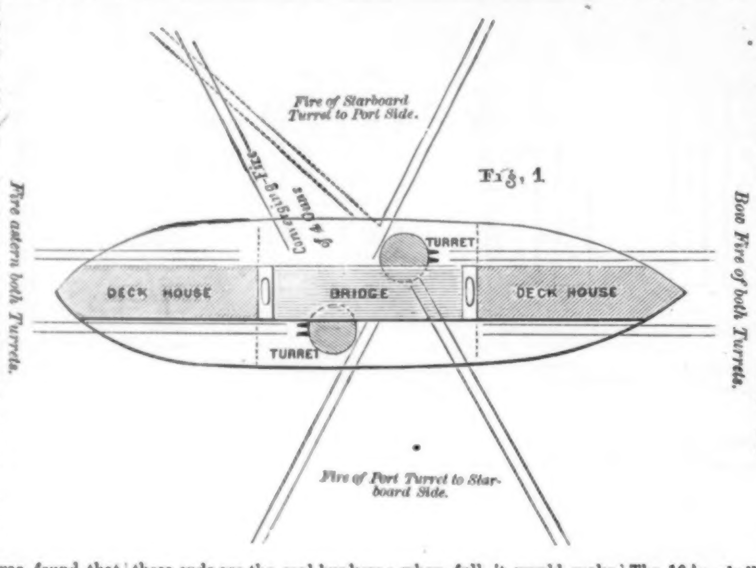


Fig. 1

The modern man-of-war is much more than an armed steamer. She is herself a great engine of destruction, provided with huge guns, clad in heavy armor, driven by powerful engines, and able to send an adversary to the bottom by one successful blow of her enormous bow. Year by year the thickness of armor and the weight of naval artillery go on increasing together; mechanical appliances have more and more replaced manual labor, both in the dockyard and on shipboard; and at the same time, the form of the ships themselves has been carefully adapted to the work they have to do and the conditions under which they must act. Our first great iron-clad, the Warrior, was only an ordinary war-steamer, very incompletely protected with armor, but quite sufficiently to resist the guns afloat in foreign navies at the time. Her armor was only 4½ inches thick; her heaviest guns were 68-pounders, weighing 95 cwt. Her immense length of 380 feet was exceeded by that of the Minotaur and her sister-ship, the Northumberland; but it was found that these long ships were not well adapted for manœuvring in line of battle, and later iron-clads were made gradually broader in the beam, and shorter in the length from stem to stern. At the same time, various minor improvements were introduced into the build, the most important of which was the change of the old oblique projecting bow into the almost perpendicular "swan-breasted" shape, which is substantially the same as that of the present running-down bow or ram. The armor was no longer restricted to the midship portion of our war-ships; it was extended fore and aft, until they were completely covered above water and a few feet below it. The weight of the guns steadily increased, and with it the thickness of armor, while turrets and the tripod system of rigging were employed to give a concentration of fire on any desired point. The Bellerophon, with 12-ton guns, was given 6-inch armor; the Hercules, with 18-ton guns, armor of 9 inches; the Devastation carries 35-ton guns, and armor of 12 inches on her sides, and 14 on her turrets; and the Inflexible, now building at Portsmouth, will have armor two feet thick, and four 81-ton guns.

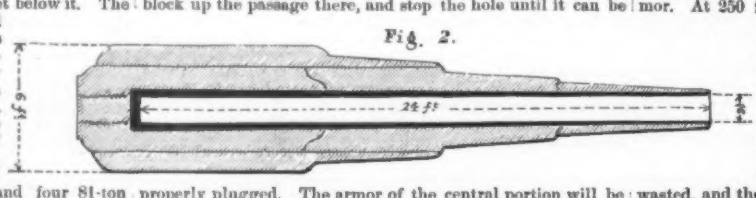


Fig. 2.

This turret-ship is remarkable as the highest development of the modern fighting-ship—for that is the best way to describe her. The navies of Europe are fast being divided into ships for coast defence, for cruising, and for action in line of battle in great naval engagements; and while fully available for the first of these purposes, the real object of the Inflexible is the last. There can not be a doubt that she will be the most powerful man-of-war ever launched, though he would be a rash prophet that would predict that she will not, erelong, be left behind in the race of improvement by some still more formidable turret-ship.

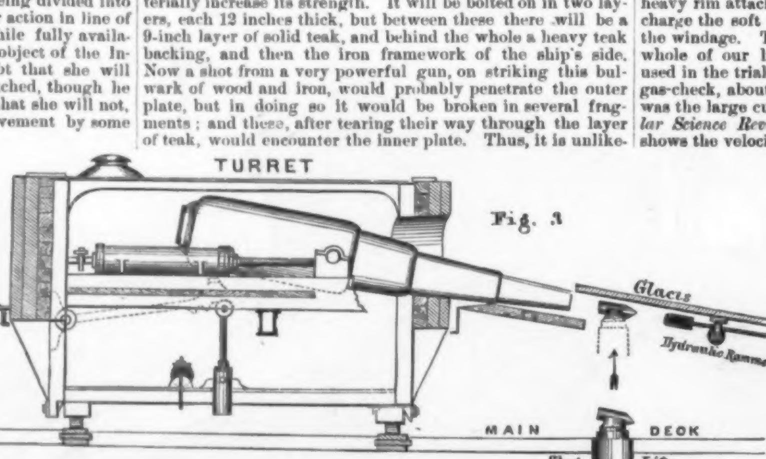


Fig. 3

The Inflexible will be 320 feet long on the water-line, and will have a breadth of beam of 75 feet. The hull will consist of two parts—the main substructure and the upper portion; the former being an iron hull, no part of which will be less than six or seven feet under water. It will be built with a ram-bow, and provided at the stern with a rudder and a pair of twin screws. On this is erected the armored central or fighting portion of the ship, which will have a height of 10 feet above the water-line, and will be 110 feet long. Upon its deck will be the two turrets, each armed with a pair of 81-ton guns. At both ends of this midship section rises a lighter structure of the same height, but having along its centre, running fore and aft, deck-houses 10 feet long and 30 feet wide (Fig. 1). The deck-houses being prolonged to the bow and stern, will give a poop and a forecastle for working the anchors 20 feet above the water. A broad bridge passing over the turret-deck will connect them, and thus give an even upper deck thirty feet wide and more than 300 feet long, extending from stem to stern. The position of the turrets in the Inflexible has been made the subject of a novel arrangement. They are placed at each end of the central deck—not in an even line with each other, but diagonally at opposite corners of it, so that one turret is on the starboard, and the other on the port side. The effect of this arrangement is that all the four guns have an uninterrupted range of fire all round the horizon. In firing ahead or astern, the guns are trained so as to send their shot over the level portions of the deck on either side of the deck-houses (Fig. 1). In firing to starboard, the port turret unites its fire with that of the starboard turret by aiming under the bridge, and *vice versâ*. Thus, while in all our other double-turreted ships, there is a fire of four guns on either beam, but of only two guns ahead or astern, the Inflexible will be able to direct her four guns at an object in any direction with respect to herself. The ship will have two or three masts, jury-rigged; none of the stays or running rigging will be brought down to the lower deck so as to interrupt the fire of the guns, all the working of the ship being carried on on the upper platform. Thus, by a simple and novel arrangement, the turret system has been brought to what we may call perfection.

The Inflexible will have four sets of engines, with an aggregate of 7000 horse-power. Her full speed, with both screws going, will be 14 knots an hour; but on ordinary occasions, she will be able to economize fuel by working only one screw and its engines. At the speed of 10 knots an hour, she will be able to carry coals for a cruise of 3000 knots, or twelve and a half days, which is about the average coal-carrying power of the best ships of our iron-clad fleet. She will also be able to use some auxiliary sail-power; and, independent of this, her try-sails will be valuable in steadying her, and keeping her head to the wind in heavy weather.

Only the central portion of the ship and the two turrets will be armored, the former with two feet, the latter with a foot and a half of armor, for even if the lightly-built ends were riddled with shot, the ship would still keep afloat. In these ends are the coal-bunkers; when full, it would make very little difference, even if water got in among the coal, and when they are empty, the ship would be much lighter, and have more floating power. But whether empty or not, the ends will not be wholly unprotected. A narrow passage will lead round them at the water-line, just inside the inner skin of the ship. The sides of this passage will be lined with cork, so that a shot passing through it will make a small, clean hole. At various points in the passage, masses of packing will be ready to be shoved backwards or forwards to the place where the shot has passed through, so as to block up the passage there, and stop the hole until it can be properly plugged. The armor of the central portion will be the heaviest ever yet floated. It will be no less than 2 feet thick; but this does not by any means express its full resisting power, for it is arranged on a new system which will materially increase its strength. It will be bolted on in two layers, each 12 inches thick, but between these there will be a 9-inch layer of solid teak, and behind the whole a heavy teak backing, and then the iron framework of the ship's side. Now a shot from a very powerful gun, on striking this bulwark of wood and iron, would probably penetrate the outer plate, but in doing so it would be broken in several fragments; and these, after tearing their way through the layer of teak, would encounter the inner plate. Thus, it is unlikely that even a shot from the 81-ton gun could penetrate such armor, and it would probably require several shots striking in succession on the same spot to make a breach. As yet this is only theory, but there is very little doubt that it would be confirmed by experiment. It would be well worth the cost of putting up a target at Shoeburyness, and sending the 81-ton gun down there. Compared with the 12-inch armor of the Devastation, it has been calculated that the strength of the armor of the Inflexible is as 2½ to 1; but the calculation has been based only on the thickness of the iron, the element of strength derived from its peculiar arrangement being left out of account, and the comparative resisting power of the armor of the Inflexible must be very much higher. With this immense mass of metal on her sides, with 18 inches of it on her turrets, and an armament of four 80-ton guns, her displacement is 10,866 tons, but she will have three feet less draught of water than the Dreadnought,* though that ship will carry only 14-inch armor and four 35-ton guns.

But the ram and the torpedo are now weapons perhaps even more formidable than the gun; and, while her armor may be relied upon to protect the Inflexible, at least from any gun now afloat, ample care has been taken to obviate as far as possible the dangers of ram and torpedo attacks. The handiness of the ship with both her screws going will make it very difficult for a hostile ram to give her a fair blow, but should she receive injury her peculiar structure—by which she is divided into an under and upper portion, with numerous water-tight compartments—would keep her afloat even with a large breach in her side. In addition to the ordinary bulkheads running across the ship, she will have one dividing her amidships in the direction of her length, and separate bulkheads specially constructed to isolate and protect the engines and boilers. In all, she will contain no less than 127 water-tight compartments; but numerous as they are, care has been taken to plan them so as not to interfere with the working of the vessel. The bottom will be double, and divided into several cells, in order to prevent any extensive injury from the explosion of a torpedo.

The armament of the Inflexible will be composed of four of the heaviest guns ever constructed, of which the experimental 81-ton gun now being tested at Woolwich is the type. Fig. 2 is a sectional sketch of the gun, showing the arrangement of the wrought-iron coils welded round the massive central steel tube. This tube, which forms the core of the gun, is bored out of a solid ingot, which cost about 1700*l*. The bore is 24 ft. long, and rifled from the muzzle to within a few feet of the base of the tube, where the unrifled portion forms the powder-chamber. The greatest external diameter of the gun is 6 ft.; at the muzzle it is just 2 ft. in diameter. The full calibre of the piece will be 16 in. The experimental gun has as yet been only bored out to 14½ in.; for the second series of experiments it will be given a calibre of 15 in.; it will then be bored to the full calibre of 16 in. and finally tested. Meanwhile the four guns which are actually to be mounted in the turrets of the Inflexible are in process of manufacture at Woolwich Arsenal.

The following are the approximate weights of the charges and projectiles for the various calibres of the 81-ton gun:

Calibre. inches.	Charge. lbs.	Projectile. lbs.
14½	220	1250
15	250	1350
16	300	1650

The 16-in shell of the 81-ton gun will weigh nearly three quarters of a ton; the bursting charge will be about one hundred pounds—that is, a whole barrel of gunpowder. Only the first series of experiments (those with the calibre of 14½ in.) is complete, and the gun is now being bored out to 15 in. The experiments occupied four days—Sept. 16, Nov. 18, and Dec. 9th and 10th—and gave excellent results. The coils and the steel tube bore the enormous strain without receiving the least injury or displacement, while the gun gave a very high initial velocity to its projectile, and there is little doubt that at 1000 yards it would penetrate 20 in. or even 24 in. of armor. At 250 feet the flat-headed bolts used in the experiments were buried 50 feet in the sandy butt at the end of the proof-ground. The experiments have shown, too, that the action of the pebble powder is perfectly under control; that by using the various sizes a greater or less velocity can be given to the shot, a greater or less strain brought to bear upon the gun. By means of Major Maitland's gas-check all windage is stopped, and thus none of the force of the powder is wasted, and the bore and rifling of the gun is saved from erosion by the gas escaping round the shot, which wears out muzzle-loading guns more rapidly than any other agency. Maitland's gas-check consists of a plate of copper with a heavy rim attached to the base of the shot. On firing the charge the soft copper is forced into the grooves, and stops the windage. This gas-check is now in use throughout the whole of our heavy artillery. The flat-headed projectiles used in the trials of the 80-ton gun weighed, including the gas-check, about 1260 lbs. The powder used in the charges was the large cubical pebble-powder described in the *Popular Science Review* in January last.* The following table shows the velocities and maximum pressures in the powder-chamber on each occasion:

September 17, 1875.

Round.	Charge. lbs.	Description of Pebble-Powder.	Initial velocity. Feet per second.	Pressure on gun. Tons per sq. inch.
1	170	1·5 inch cubes	1393	24·2
2	190	1·5 " "	1423	22·3
3	210	1·5 " "	1475	24·8
4	220	1·5 " "	1,503	22·2
5	230	1·5 " "	1550	29·6
6	240	1·5 " "	1551	27·3

November 16, 1875.

Round.	Charge. lbs.	Description of Pebble-Powder.	Initial velocity. Feet per second.	Pressure on gun. Tons per sq. inch.
1	220	1·5 inch cubes	1525	25·8
2	220	1·7 " "	1420	20·6
3	230	1·7 " "	1454	20·2
4	240	1·7 " "	1470	21·0

December 9, 1875.

Round.	Charge. lbs.	Description of Pebble-Powder.	Initial velocity. Feet per second.	Pressure on gun. Tons per sq. inch.
1	220	1·5 inch cubes	1535	24·1
2	220	1·7 " "	1502	23·0
3	220	2·0 " "	1485	21·7
4	230	1·7 " "	1543	24·9
5	230	2·0 " "	1498	23·4
6	240	2·0 " "	1513	23·0

December 10, 1875.

Round.	Charge. lbs.	Description of Pebble-Powder.	Initial velocity. Feet per second.	Pressure on gun. Tons per sq. inch.
1	220	1·5 inch cubes	1440	28·1
2	220	1·7 " "	1414	25·1
3	220	2·0 " "	1366	24·4
4	250	2·0 " "	1523	24·8

Rounds 1, 2, 3 of December 10th gave exceptional results, as they were fired with a projectile of 1460 lbs., and consequently the velocities obtained were much lower and the pressures proportionally higher than with the smaller projectile ordinarily employed. It will be observed that pressure and velocity increased with the weight of the charge, but decreased

* The greatest draught of water of the Dreadnought will be between 26 and 27 feet. Until a few weeks ago, and before her change of name, the Dreadnought was known as the Fury.

* Article, "Gunpowder, its Manufacture and Conveyance." By A. Hilliard Atteridge, January, 1875.

as the size of the pebbles was augmented, the pressure, however, decreasing in a much greater ratio than the velocity. Thus the action of the charge is completely under control.

It has been assumed that it will be well to keep the pressure of the gas in the powder-chamber below 25 tons per square inch; and these experiments show that this can be easily accomplished, while at the same time giving a very high initial velocity to the shot. When the gun is bored out to its full calibre, it will probably give even more striking results.

Mounted on the ordinary carriages and slides, and worked by manual labor, these huge guns would be almost unmanageable, and at best would deliver only a slow inefficient fire. But all difficulties in the way of using them with good effect have been removed by an invention of Mr. Rendel, of the Elswick Works, which will make these monster pieces of artillery more handy than even the old 68-pounders.

The leading features of the arrangement are shown in Fig. 2. Two guns will be mounted side by side in each turret. Each gun will be mounted so as to be supported on three points. The trunnions will rest on blocks sliding on fixed beams bolted down to the floor of the turret, while the breech will rest on a third block, sliding like the others between guides, upon a beam or table. Behind each of the trunnion-blocks, in the line of recoil, are two hydraulic cylinders, connected with them by piston-rods. The cylinders communicate by a pipe, on which there is a valve, that, on the recoil of the gun, opens and allows the pistons of the rams to run back slowly, checking the recoil. By reversing the apparatus, the gun can be run out again. The beam on which the breech rests is supported by a third hydraulic ram, fixed vertically beneath it in the turret. By this means the breech can be easily raised or lowered, thus elevating or depressing the muzzle of the gun, which pivots on its trunnions with a large preponderance towards the breech. In order to load, the muzzle is depressed until it comes opposite to an opening made in the upper deck before the turret, and protected by a sloping armored glacis. A hydraulic rammer works in guides through this hole, and the rammer-head is hollow, and is so constructed that when it is driven into the recently-fired gun, and comes in contact with the sides of the powder-chamber, a valve opens, and it discharges through a number of holes small jets of water, thus acting as a sponge, and extinguishing any remnants of the charge or of the products of the explosion which may have remained smouldering in the bore. It is then withdrawn, and a hydraulic shot-lift raises up to the muzzle of the gun the charge, the projectile, and a retaining wad, and then a single stroke of the rammer drives them into the gun and home to the base of the bore. Again the rammer is withdrawn, the hydraulic ram under the breech of the gun elevates the muzzle, the turret swings round, and the shot is fired. A 9-inch gun, mounted experimentally in a turret at Elswick, and loaded on this system, was brought to the loading position, sponged, loaded, and brought back to the firing point in twenty-three seconds. Equally rapid loading was effected with the 38-ton gun during the experimental trial of the hydraulic gear on board the Thunderer. Thus the first advantage of the system is rapidity of fire; the second is economy of labor. One man only for each gun is stationed in the turret, another works the hydraulic rammer on the main deck, six or eight others are employed in bringing up the ammunition to the shot-lift by means of a small tramway. There are two sets of loading gear for each turret; but even if both were put out of order, the gun could still be loaded, with an ordinary rammer and sponge, by a number of men stationed on the main deck.

The adoption of the system enables very heavy guns to be carried in comparatively small turrets. Those of the Inflexible are very little larger than those of the Devastation; so that with the old plan of having a numerous crew in the turret, and running in the gun in order to load it by hand, only the 38-ton gun could be carried. As it is, it is quite possible that the Inflexible will be armed with even a more tremendous weapon than the 81-ton gun. This has been held in view in designing the ship; and, by a slight modification, it will be possible to mount in each of her turrets a pair of 160-ton guns, with a bore of 30 feet and a calibre of 20 inches.

A minor feature, which will perhaps be introduced in connection with guns of large calibre, is a steel plug containing within it a detonating apparatus for firing a charge of powder. This is intended to be fixed in the vent of a heavy gun, in order to prevent the upward escape of the gas and the consequent gradual erosion of the vent. This erosion very rapidly widens the vent, and at last disables the gun, and the fire has to be suspended until it is revented. Thus this system of firing, which has been invented by Captain Noble, R.A., would greatly increase the efficiency of the gun.

Some idea of the amount of ammunition required for the 81-ton gun will be given by the following calculation: Let us suppose that in an action the Inflexible would fire only ten shots from each of her guns; she would use up more than 1300*l.* worth of ammunition, burn upwards of 100 barrels of pebble-powder, and hurl nearly thirty tons of iron at the enemy.

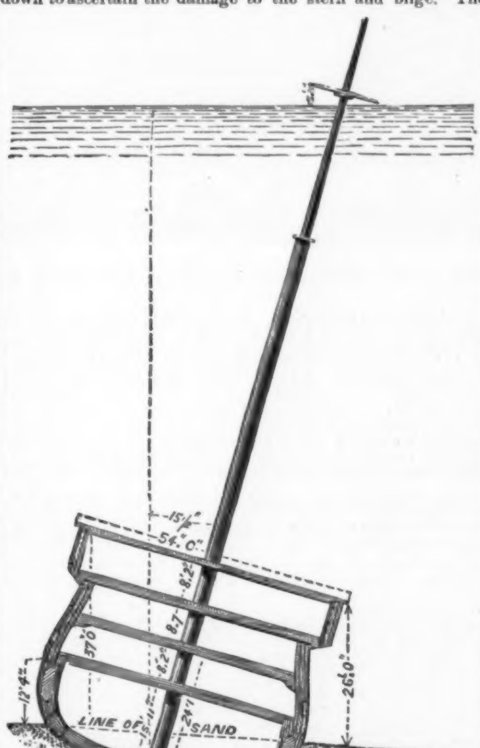
As a new type of man-of-war, we may sum up the leading features of the Inflexible as follows: The armor is confined to the central fighting portion, and to the main substructure which floats the ship. An armored deck, seven feet under water, divides the vessel into two separate portions. The unarmored ends are so constructed that the vessel will float even when they are penetrated. The ship has a wide beam and a comparatively light draught. The deck-houses give a high bow and stern, and the turrets are so arranged as to enable all four guns to be fired both ahead and astern, or on either beam. The Inflexible has been accepted as the type of our future line-of-battle ship; a few years may perhaps introduce into naval warfare such changes as to render the principles on which she has been constructed obsolete. But with our present knowledge no better design could be adopted, and already the government has determined on immediately laying down two new ships of the same type, but of smaller size. They are to be called the Ajax and the Agamemnon. Their displacement will be about 8000 tons—that of the Inflexible is 11,000. They will carry 18 inch armor on the central section, and two 38-ton guns in each of their turrets.

A MECHANICAL DEER.

THE Winchester Arms Company are to have a novel rifle range at New-Haven. A deer has been made of boiler iron, hung upon pivots and mounted upon wheels to run upon a track seventy-five feet long, which is to be placed upon an inclined plane. The deer being started from one end of the track will travel rapidly, with a loping motion, which will be sustained by a simple arrangement of springs. The marksman, standing at a distance, will fire at the deer while it is in motion and passing behind trees and blinds arranged to make the hitting of it more difficult.

RAISING THE VANGUARD.

LAST year, it will be remembered, the British iron-clad Vanguard, while steaming outside the harbor of Kingstown, Ireland, in company with the Iron Duke, was struck by the latter vessel and immediately sank. The British Government is desirous of raising the ship, but how to do it is a problem not yet solved. An opportunity for the display of the triumph of mind over matter, the latter weighing several thousand tons and lying 120 feet below the surface of the ocean, is now presented. The Admiralty have resolved on throwing the operation for raising the Vanguard open to public competition. All parties tendering must furnish satisfactory evidence of their financial ability to undertake the work; undertake to deliver the ship either in a dry dock or at the entrance of one of her Majesty's docks in such a state that she may be docked, and the delivery is to be considered incomplete till she is safely docked. The ship is to be raised and delivered whole, and not in pieces; no payment is to be made, or any claim to payment arise, until the delivery is complete; the contractors are to be responsible for any infringement of patent rights; the time by which the parties tendering propose to begin operations and the probable date of completion are to be stated in the tender. All tenders are to be for a lump sum, to cover all charges, and not for a percentage on the value of the ship, but their lordships state that they will not bind themselves to accept any tender. The Vanguard is sunk in 20 fathoms low water spring tides; 11 miles from the land; Bray-head bearing W. ¾ N. magnetic. The rise and fall of the tide is from 8 ft. to 9 ft. The current runs from 2½ to 3 knots across the ship. Her head is W. ½ N. Distance from Kingstown Harbor about 16 miles. The Vanguard is 6034 tons displacement; length, 280 ft.; breadth, 54 ft.; draught of water, 23 ft. Her frames are 4 ft. apart; her bottom plating is ⅝ in. thick. She rests on her starboard bilge, at an angle of 15° in soft sand, and since early in October last has sunk into this sand about 8 ft. 6 in. Her lower masts are standing with the wire rigging and stays in place. On sinking she struck with her stern post, but the divers have been unable to go down to ascertain the damage to the stern and bilge. The



RAISING THE VANGUARD.

aperture where struck by the Iron Duke is on the port side abaft the middle of the ship; it is 14 ft. in length and averages 2½ ft. in breadth; the upper part of this aperture is 107 ft. below the surface of the water. Plans of the ship may be seen at the Admiralty. The upper deck is encumbered with a network of rigging, ropes, etc., which have fallen with the upper masts. The divers found it dark when working on the ship unless the water was perfectly smooth, with bright sunshine. There is very little slack water; often none at all after heavy weather. The average time a diver can work is as follows: Spring tide, high water, 0h. 45m.; low water, 1h. 15m.; neap tide, high water, 2h. 30m.; low water, 3h. 0m. With wind of force 4, all operations with divers cease, owing to the sea. The time for actual work by divers has been, in 18 to 20 fathoms, from 15 to 30 minutes. The foregoing particulars are taken as well as the accompanying engraving from an Admiralty Circular.

MODERN USES OF THE GOOSE-QUILL.

THE French claim that metallic pens were first invented during the last century by a Frenchman named Arnoux; but it is certain that they were not generally introduced until 1840, when almost every one abandoned the goose-quill and adopted the metallic pen. As soon as so many millions of goose-quills were thrown out of use and at once became much cheaper, inventors began to think of some means by which all these quills might be profitably utilized, and credit is especially due to Bardin and Soyez, of Paris, for creating a new industry. They invented several ingenious machines for utilizing the large wing-feathers of various kinds of birds, a great many of which are now wasted. The number of goose-wings thrown at present into the French market is so large, and their price is so moderate, that it has been necessary to resort to the wings of other birds. Russia, Siberia, and other countries contribute largely in furnishing sufficient material to fill the demand. The goose-quills, which are by far the best for manufacturing purposes, are assorted according to fixed standards, and numbered according to their natural order; every bunch in the trade consists of quills of the same number, because each serves for a special purpose. The quill taken from the end of the wing, and which formerly, when used for writing, had a lesser value, on account of its curved shape, is now the most valuable. Such quills, when selected and large, cost at least £8 per thousand, while the ordinary quills are valued at from 16s. to 24s. per thousand. The first quill of the wing is the strongest; it has a very rigid tube, is curved, and provided on one side with a very short vane, lying stiff against the central quill; on the other side is a longer vane, and for this reason the quill was not well adapted for writing, as the two so different vanes interfered with the equilibrium, while the quill turned and twisted in the hand on account of its curvature. This fault of the quill now gives it value, because it alone furnishes the short vane, which the French call the "biot." The first step in the manufacture is to soak the quills, because they successfully pass through the various processes only in a soft, moist condition; the next step is to cut off the tube, by means of a continually operating cutting instrument, under which a female operator rapidly places the quills. The next operation is the separation of the part which the French call the "brillantine." It is a horny, excessively thin, and transparent film, which covers the back or upper part of the quill between the vanes. Like the "biot," it is a special product, and requires great dexterity to take it off. For this purpose a small penknife is used, the edge of which is placed at the thin extremity of the quill under the brillantine, when the whole is easily removed. This brillantine, showing all the colors of the rainbow, is used by French milliners for adorning ladies' bonnets, with several kinds of lustrous curled or floating feathers. These brillantines are sold in bundles containing each ten packages of a thousand. The women who take this material from the quills only earn eighty centimes (16 cents of our money) per thousand, and declare that they make good daily wages at that. When the brillantine is removed, a cut with the penknife also removes the large vane, which is then torn off and put aside. This ends the manual operation upon the quills; the next series is all performed by machinery, and begins at the top of the quill. A woman operator presents the thin top end to the machine, which is a kind of miniature rolling-mill, and presses the quill against the edge of a kind of plane, which shaves off the upper covering or horny film under the brillantine. Another woman then takes the quill, turns it round, and passes it reversed through another similar little rolling-mill, so as to let the chisel-blade take off the horny layer, split up by a groove, and situated on the lower part of the quill. This second operation is much more difficult than the former, because the quill has now nearly all its consistency. The woman who has charge of this machine receives higher wages than the other. One pound of these films contains at least three thousand pieces, but a good operator can make six pounds, or eighteen thousand pieces, per day, notwithstanding they have to be passed one by one through the rolling-mill.

The horny films shaved off from the quills by the former operation are handed to women and children, who pass them one by one through a machine, by which they are divided lengthwise into a number of fine round wires or threads, like very stiff hairs, by means of cylinders with circular grooves and cutting edges between. These hairs are afterwards dyed with any color desired, and used for making the most excellent brushes, which, however, are never found in the English or American markets, nor even in France itself, where they are manufactured; they are all absorbed by Germany, where their good qualities are appreciated, and this is also beginning to be the case with the French marine. They are also used by manufacturers of artificial flowers and fruits to make various parts, such as thorns, beards, etc.; but usually the refuse material is employed for this purpose. The marrow, which is left after the various operations described, is brought, while mixed with refuse of the other parts, to a special work-room, where it is submitted to a new series of transformations, invented by M. Bardin, and by which it is changed into an admirable plush, used in the manufacture of the so-called velvet wall-papers for the decoration of our rooms. To make these papers, the parts of the surface to be thus prepared is first covered with glue, so as to become sticky, when the plush is sifted over it, and adheres. In former years the short wool cut off by the finishing up of woven cloth was used, and formed a woollen plush, but at present, in France, the refuse of the goose-quills furnishes a plush much finer than wool, it takes the various dyes better, is more solid, level, and even, and for these reasons it has among the manufacturers of wall-paper superseded entirely the wool plush. The wall-papers thus prepared are very firm, while the velvet covering never comes off. In regard to the large vanes, they are brought to a dyeing establishment and given any desired color, because a peculiarity of the quills is that there is no object which so well, easy, and permanently takes any die desired. Besides, by means of certain additions to the dye-stuff, these vanes may be made absolutely proof against moth. From the dyeing establishment they are taken to the weaver, who interlaces them between the threads of his production, and in this way forms a kind of hairy surface, the hair of which can never fall out, being retained by its natural connection. The horny nature of this material offers such a natural resistance to wear and tear, that in order to curl them and give a moiré appearance to such carpets, it is necessary to submit them for several hours to the action of the hard brushes made of the horny films, described above, and driven by steam-power. The final appearance is that of a heavy, thick plush, to which neither mud nor dust will adhere. Every observing person must have noticed how much easier dried mud can be brushed from good cloth made of pure wool, than it can from the inferior qualities of cloth, adulterated with cotton; to the latter the dust will stick, and often requires water, or even water and soap, to remove it. It is a provision of nature to endow the wool of sheep and the hair of other animals with such properties as to offer no adhesiveness to mud, dirt, or dust; and the plumage of birds unites this property in the highest possible degree with an almost incredible amount of resistance against wear and tear. All this is natural when we consider the great amount of wear and tear the plumage of birds is exposed to, as well as their contact with dirt when obliged to seek their food in muddy localities. Among the tubes separated by the first operation from the rest of the quills, those which have the least value (and those of ducks are also used for this purpose) are changed into toothpicks by means of a special machine, the invention of a M. Soyez, which cuts the toothpicks with a single blow.

DIAMONDS as well as carbon are rapidly growing into favor for purposes herein enumerated, namely: drilling, quarrying, reaming, burring, sawing, turning, planing, moulding, chasing, shaping, carving, engraving and dressing agates, millburrs, grindstones, Arkansas marble, slate, granite and other stones, nickel, iridium, enamel, crystal, porcelain, etc., also for trueing up emery-wheels, hardened steel and paper calleuder rollers, screw taps, arbor-holes, cast-iron cylinders, etc.

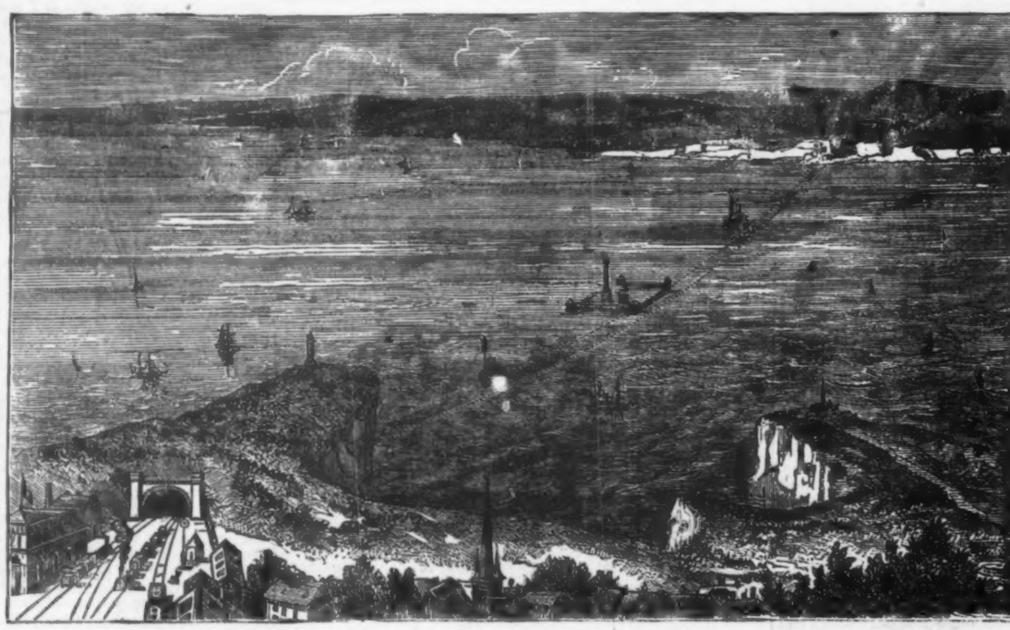
[Engineer.]

THE ENGLISH CHANNEL TUNNEL.

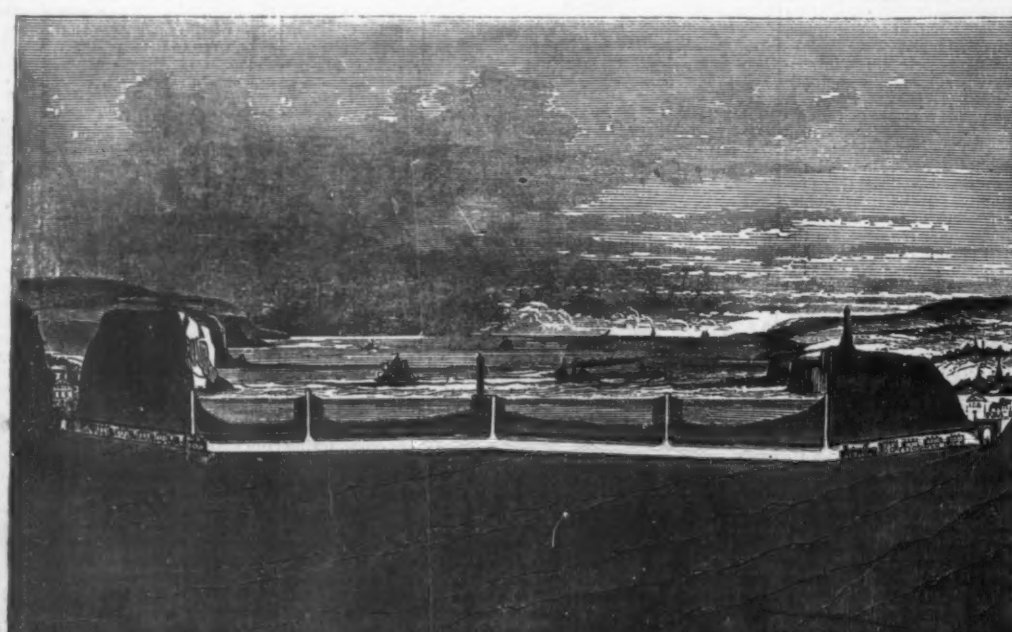
THE English Channel Tunnel Company was formed in 1872, at least it was incorporated on the 15th of January in that year. The object of the company is the construction of an underground tunnel beneath the Straits of Dover between England and France. The first important act of the company was the deposit of a bill, of very modest proportions, the preamble of which recites, "that whereas it is expedient, for the proposed carrying out of preliminary experimental operations in connection with the objects aforesaid, the company should be empowered to purchase and take certain lands, houses, and buildings at the foot of the cliff in St. Margaret's Bay, in the parish of St. Margaret-at-Cliffe, in the county of Kent, lying between Ness Point and Coney Burrow Point, and including the beach and foreshore abutting on such lands." The company asked to be empowered by Parliament to purchase the said land compulsorily if necessary. The piece of land thus asked for is of very moderate dimensions, and is to be used for the purpose of putting down trial borings. If these are successful, a shaft is to be sunk and headings driven; as to the further steps to be taken, they remain to be settled. This bill was deposited long since, but no very energetic action appears to have been taken to get it passed for some time. On the 22d of last March, letters were addressed by the Lords of the Treasury to Mr. Kennedy, Captain Tyler, and Mr. Watson stating that it appeared to be very desirable that before any powers were conferred on the company an understanding should be arrived at, not only with the company itself, but also and primarily with the French Government, on these points, which are of international importance, such, for instance, as the question of the limits of jurisdiction of each country within the tunnel, and the question of closing or otherwise neutralizing it in time of war, or apprehended war. It was accordingly suggested that a small joint commission should be appointed by the two Governments to settle these questions. The French Government deputed MM. Kleitz, Droeling and De Lapparent, while the English Government selected Mr. Kennedy, Captain Tyler, and Mr. Watson to act on their behalf. Apparently without waiting for any definite expression of opinion on the part of the commission, the Board of Trade recommended, on the 1st of July, 1875, that the bill of the Channel Tunnel Company might be allowed to proceed through Parliament without further opposition, provided the company would accept certain clauses limiting the time during which they might retain possession of the land at St. Margaret's Bay, in case the works were not proceeded with. These amendments were accepted, and the bill received the royal assent on the 2d of August, 1875. The English Government from first to last have dealt very cautiously with the whole question, and while they will offer no opposition, they demand in return that they shall be asked by the company for no pecuniary assistance in any shape or way. The French Government, on the contrary, have taken up the scheme warmly, and on the 2d of August, 1875, a concession was granted to MM. Michel Chevalier, Fernand Raoul Duval, and Alexandre Lavalley, president and members of a society registered on the 9th of February, 1875, said society having for its object the construction of a tunnel and railway under the Straits of Dover. As the matter stands at present, then, we have two distinct companies—one French and one English — working harmoniously, it is to be presumed, with a common object in view. All this possesses very little engineering interest, but it is well that our readers should understand the precise nature of the agencies now at work. The Blue-book supplies no information whatever as to the steps that have been taken by the companies, and we confess that we have been unable to ascertain that any works are in progress, except the taking of soundings by the French company; possibly in spring some energy will be displayed. The Blue-book does, however, furnish a good deal of information as to the proposed route of the tunnel. St. Margaret's Bay lies a short distance to the north of the South Foreland, and a railway will have to be made from this point, in order to place the tunnel in communication with Dover. On the French side the tunnel would terminate about half way between Calais and the village of Sangatte, the route being almost parallel with that of the telegraph cable between Dover and Calais. By a short line the tunnel would be united to the Chemin de fer du Nord, and thus, we may almost say, with the whole railway system of France. The route is very nearly the shortest that could be taken. The total length would be about 48 kilos., or say about 29¾ miles, but the portion of the tunnel under the bed of the Channel would occupy only about 22 miles, the remainder being required to connect surface lines with the tunnel at each end. The depth of the floor of the tunnel below high-water mark is 127.185 metres, or a little over 416 ft. in round numbers. The tunnel is to rise from each end toward the middle at the rate of 0.37 metre per kilometre, and deep sumps are to be made at the bottom of the shafts into which the drainage will flow, and from which it will be pumped.

It is assumed that the success or failure of the scheme will depend on whether the grey chalk, through which the tunnel must be driven, is or is not free from faults or fissures, which may admit water from above. But from this conclusion, thus stated, we dissent. If it be intended to convey the impression that the presence of water in great quantities would prevent the formation of a tunnel under any conditions, then the statement is probably erroneous. We have very little doubt that if time and money enough were available, Sir J. Hawkshaw and Mr. Brunlees, the engineers of the undertaking, would contrive under any circumstances to pierce the bottom of the Channel, and leave behind them as they went walls of iron or brick which would defy the sea.

In this connection, we give two illustrations of the plan for the Channel tunnel, designed by the well-known French Engineer, Thomé de Gamond. He proposes to erect five air-shafts along the line of the tunnel, to be surmounted by great lighthouses. Three of the shafts rise above the surface of the water as shown. The central shaft is also to be provided with a harbor of refuge or dock, for the shelter of tempest-tossed vessels. The central shaft and dock will also be used as a railway passenger-station, for the railway, where passengers arriving and departing by coastwise steamers may leave or take the cars, the shaft being provided with lifts or elevators for that purpose.



PROPOSED TUNNEL UNDER THE ENGLISH CHANNEL BETWEEN ENGLAND AND FRANCE



PROPOSED TUNNEL UNDER THE ENGLISH CHANNEL BETWEEN ENGLAND AND FRANCE.

THERMIC EFFECTS OF SUGAR INVERSION. By G. FLEURY.—It is shown that heat is given out when sugar is inverted. In one experiment with 500 grams of dilute hydrochloric acid (containing 38 grams of real acid), a solution of 60 grams of sugar in 30 grams of water (proper precautions having been taken to have the liquids at the same temperature—namely, 49·5° before mixing), a rise of 2·6° occurred.

USING THE RAW MATERIAL TO THE UTMOST.

ONE of the greatest discoveries ever chronicled is that of petroleum. Its importance is even yet but half comprehended. Nature's economy, in all of her productions, is in no instance more strikingly illustrated than the varied merchantable commodities that are wrought from crude oils that are so bountifully deposited in some sections of America, and the great waste that attended its treatment would do for an excellent text for a telling sermon on the startling ignorance of man, and its rapid disappearance under the incisive application of his intellect. Upon the first discovery of the oil in the Pennsylvania districts, of course immense quantities were lost while yet in a crude state, owing to the inadequate means and contrivances for preserving it; then in treating the product the residue in the stills of the refiner was regarded as fit only for fuel. This was, however, soon found to be an error, and the tar was taken from the oil refinery, submitted to another treatment, and paraffine oil is the result. Again, a residuum was found, and this, in its turn, is now pressed and refined, and enters largely into the manufacture of candles. Submitted to a still further treatment, the wax becomes a transparent and tasteless mass, in which condition it is converted into chewing-gum. After undergoing all these varied treatments, there still remains a hard, crisp cinder, which still contains sufficient live matter to render it combustible and fully equal to the best coal in its heating qualities, and this, notwithstanding the fact that in its latter treatment the mass is submitted to a white heat, which one would naturally suppose would so thoroughly disintegrate the matter and render any residue unfit for any purpose, much less a fuel. What science may yet accomplish in drawing from this cinder an article to swell the list of analogous products, is as yet undetermined; but we are not prepared to believe that even this mass, although it leaves scarcely a vestige of ash, after being burned as a fuel, will be allowed to go to waste.

CEMENT FOR FASTENING CAOUTCHOUC ON METAL.

IN making combinations between steam and other pipes and apparatus, india-rubber plates and rings are almost exclusively used, and the impossibility is often very disagreeably felt of effecting a secure combination. By the use of a cement which will adhere to india-rubber as firmly as to metal or wood, the above difficulty is quite removed. A cement of this kind is prepared by softening pulverized shellac in ten times its weight of strong ammonia, whereby a transparent mass is obtained, which becomes fluid in three or four weeks, without use of hot water. This solution softens the caoutchouc; after evaporation of the ammonia, however, it hardens, and becomes impervious both to gases and to liquids.

RESISTANCE OF SLAG BRICKS TO CRUSHING STRAINS.

M. LEON CAHIER, in an interesting report to the *Société Scientifique Industrielle* of Marseilles, comes to the following conclusion: Bricks made by the Funel machine with a single pressure offered, after being made 140 days, a mean resistance of 49·2 kilogrammes per square centimetre—704 lb. per square inch — and after a year their resistance was 77·7 kilogrammes per square centimetre—1105 lb. per square inch—while the resistance of bricks made by the Devaux machine, with double pressure, was twice that of the former.

HOT-BLAST PIG FOR REFINED IRON.

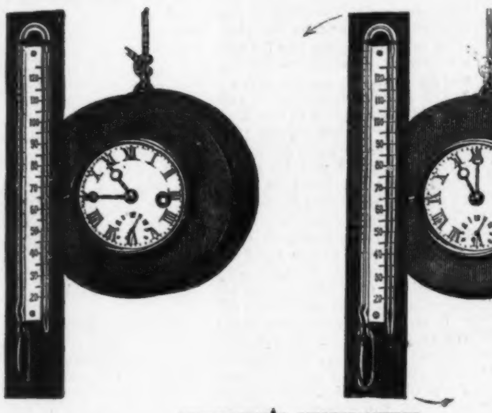
M. FERNAND HAMOIR turns a hot blast into the blast furnace just before the metal is run, the operation being performed rapidly with a cheap and simple apparatus. The advantage obtained is a pig which gives, it is said, one charge more to the puddling furnace in 24 hours and an iron perfectly refined and capable of being welded. The books of the iron works where this method was adopted show an increase in the production of iron, when the hot blast was used, amounting to an average of 250 kilogrammes—4 cwt. 3 qr. 19 lb.—per charge. The loss due to the blast is compensated for by a diminished waste in the puddling furnace, which does not exceed 7·88 per cent.

REGISTERING THERMOMETER.

THE apparatus represented by this cut can be usefully employed to determine the temperature of inaccessible places, such as bottoms of wells, regions of air inferior to those navigated by aërostats, etc.

It is composed of a mercurial thermometer, bent around, as the figure represents, and fixed on a board furnished with the Fahrenheit scale. The cylindrical tube containing the mercury is slightly compressed at the point which corresponds to 0°. When the thermometer has taken the temperature of the ambient medium, if it is made to turn a central axis and a complete revolution is made, the column of mercury, which indicates the temperature, is destroyed at the point of compression, and passes into the other branch of the U tube from the reservoir.

The thermometer is fixed to a clock, resembling an alarm-clock. By placing the hand of its inferior dial at a given hour, the thermometer will have accomplished its rotation when the clock indicates that hour, and the column of mercury, isolated from the reservoir, will subsequently indicate the temperature.



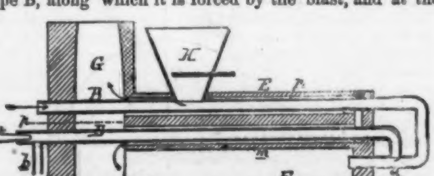
REGISTERING THERMOMETER.

To better explain the office of this ingenious system, we will suppose that we desire to take the temperature of the bottom of a well. The apparatus is in the position represented by the left engraving. It is ten o'clock and forty-five minutes. The left branch of the thermometer indicates a temperature of 60° Fah. The clock and the thermometer are attached to a rope and lowered to the bottom of the well in two minutes; the thermometer will have taken the equilibrium of temperature in ten or fifteen minutes. The hand of the inferior dial is placed at eleven o'clock. The apparatus reaches the bottom of the well, and is allowed to remain there fifteen minutes, when the clock indicates eleven, and the thermometer has accomplished its rotation in the direction indicated by the arrows of the right cut, when it is turned, the column indicating the temperature has passed into the right branch of the glass tube. This registering thermometer, due to a skilful Englishman, M. Negretti, was frequently used by the members of the *Challenger* expedition for taking the temperature of the ocean at different depths. The apparatus is completed for this purpose with coverings which protect it from the action of the water.—*La Nature.*

COAL-DUST AND PETROLEUM FURNACE.

By J. K. CALDWELL, Philadelphia, Pa.

THE drawing is a vertical section of a puddling or heating furnace, through the roof E of which, as well as through the chimney G, pass the two pipes B and D, the former for admitting air under pressure, and the latter for receiving a jet of steam from a nozzle *a*, the said jet inducing petroleum or other hydrocarbon to pass from any adjoining reservoir through the branch *b* into the said pipe D. Both of the pipes B and D communicate with a short pipe or nozzle *d*, which projects into the interior F of the furnace at the front end of the same. With the pipe B communicates a hopper H for containing coal-dust, more or less of which can be admitted to the said pipe by manipulating a sliding damper or other equivalent device. When the furnace is in operation, the roof is always in a heated condition; hence the petroleum injected into the pipe D in the form of spray by the steam-jet must, owing to the heat imparted to the pipe, assume a gaseous form before it reaches the nozzle *d*, where it unites with the supply of compressed and heated air forced through the pipes B, the two elements forming a highly inflammable gas, which burns with an intense heat in the interior F of the furnace. The coal-dust passes from the hopper H into the pipe B, along which it is forced by the blast, and at the



COAL-DUST AND PETROLEUM FURNACE.

same time so heated by the latter that on escaping from the nozzle *d* into the furnace, it is in a condition to be instantly consumed by the flame, thereby adding to the intense heat of the same.

IMPROVEMENT IN METALLIC ARCHED TRUSS-BRIDGES.

By JAMES B. EADS, of St. Louis, Mo.

CONSISTS in prolonging or extending the arches landward beyond the abutment-joints, and downward nearly or quite to the earth, so as to reduce the quantity of the masonry on which to receive the thrust of the arches, and the cost of the abutments of the span.

The arches A A, inverted arches B B, and brace-work C C, constituting the two half-spans, will be connected by hinged joints at *a a a* to the arch extensions A′ A′, and at the centre of the span by the hinged joints *a′*. D represents the roadway connected to the arches by vertical suspension-rods F; or this may be supported by struts on the arches, if the roadway be placed above the arches.

METALLIC ARCHED TRUSS-BRIDGE.

The arch-extensions A′ A′ may be of any suitable form and construction to sustain the thrust of the two half-arches constituting the span, and they may be arched or trussed to support the roadway D, as shown in the drawing.

G G are the abutments sustaining the entire arched structure, and if the main arch A A and its extensions A′ A′ are in the form of a parabola, the centre of pressure will pass through the joints *a a* directly to the abutments G G, and no vertical strain will be put upon the columns E E if the bridge be either unloaded or equally loaded from end to end of the entire structure.

With an unequal load, vertical strains will occur in the columns, compressive ones on the loaded side, and tensile or upward strains in the columns under the unloaded side. These will be very small, however, compared with the total weight of the span and its load, and therefore these columns will require very little material in their construction.

By slightly increasing the distance, as determined by the parabolic curve, between the abutments G G, the line of pressure may, under all conditions of unequal loading, remain in or below the arch-extensions A′ A′, and then compressive strains only will occur in both columns. If this is not done, the columns may require to be anchored down to restrict the tensile strains.

The arch-extensions A′ may be strengthened and supported on the under side by inverted arches B′ and brace-work C′, or by any suitable form of trussing.

IMPROVEMENT IN HYDROCARBON FURNACES.

By J. C. RAMSDEN, Lightcliffe, Eng.

THIS invention has for its objects the construction of portable apparatus for generating and applying heat.

The fuel used is water in a state of vapor, and some of the volatile hydrocarbons, of which paraffine and petroleum are a type. This invention consists in an improved apparatus for effecting the union and combustion of the said fuels. Attached to a small boiler or steam-generator A, I fix a number of horizontal tubes B, which terminate with minute orifices, so that the water, when formed into steam, rushes out in a fine spray. Underneath the horizontal tubes B, I attach vertical tubes C, the lower part of which take into a trough or reservoir D E, containing the liquid hydrocarbons. The upper portions of the vertical tubes terminate in a capillary orifice.

The *modus operandi* is as follows: When the water is converted into steam, it is discharged with considerable force through the horizontal tubes, the vertical tubes are ex-

FIG 1 FIG. 3.

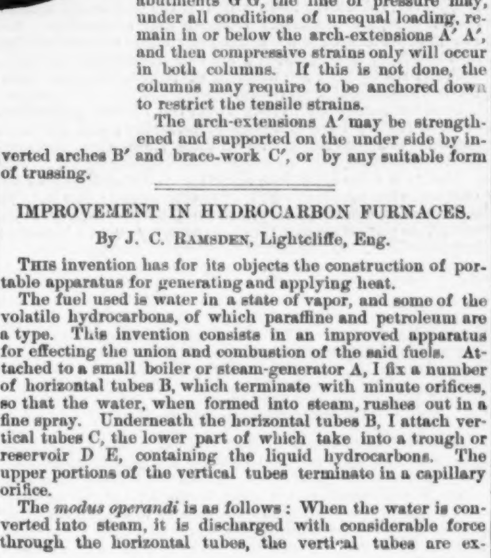


FIG 2

RAMSDEN FURNACE.

hausted, the volatile hydrocarbon rises to fill the vacuum, and, reaching the capillary orifices at the top, is caught by the rushing column of steam and blown into the finest spray, the result of which is that an intimate union of the two liquids is effected, a light is applied, and combustion at once takes place. An immense heat is generated with a complete absence of smoke.

This apparatus can be made of any convenient size. It is portable, and can be moved about from place to place, and can be applied with great advantage to a variety of purposes—to the melting of metals, to the rapid raising of steam, or supplying clean, hot, dry air to any or every conceivable purpose. When more steam is desired than is supplied by pipes B, it is admitted through pipe D′, which communicates with the generator A.

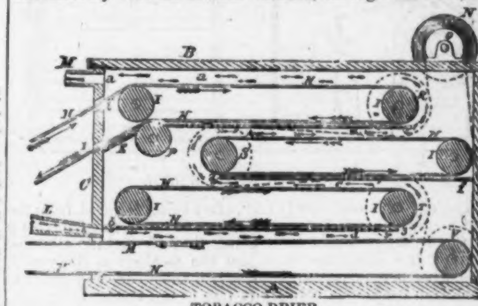
F is a case, which may be straight or curved, for directing or diverting the heat and flame to any required point or object.

DRYING TOBACCO AND OTHER SUBSTANCES.

By D. B. CHAPIN, Covington, Ky.

CONSISTS in providing a series of endless carriers, arranged in a series of zigzag flues, through which a current of air is forced or drawn to carry off the moisture evaporated, and to speed the drying operation.

The article to be dried is placed upon the top apron outside of the chamber, and is carried by the apron into the upper flue, and passed slowly through it. As the apron passes over the drum at the rear end of the flue, it is dumped on to the apron beneath in the next flue, and the material is thereby turned over, so as to present other surfaces to the current of air, which is forced through the flues over the top surface of the aprons. This same mode of operation is carried successively through each of the flues, and the tobacco is finally carried out of the chamber by the bottom apron, from which it is removed. A current of air is forced over the aprons, passing successively over the several carriers, through the flues, and



TOBACCO-DRIER.

escapes charged with moisture at the top at M. This outlet may be varied in size and location, and one or more escape-flues, regulated by a damper, may be employed.

Scrapers may be placed under each of the aprons at 1 2 3, as shown, to prevent the material from adhering to the under side of the aprons.

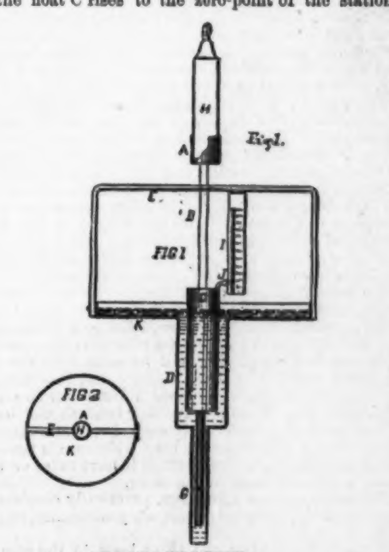
When it is desired to moisten tobacco, it is fed into the drier in the same manner as for drying, and, instead of forcing a current of dry or heated air through the flues, a jet of steam or a current of humid air is introduced into the flues, and the tobacco on the aprons absorbs the moisture from the air, and is cased or dampened by this process.

NEW PHOTOMETER.

By P. MUNZINGER, Philadelphia, Pa.

FIGURE 1 is a vertical diametrical section; Fig. 2 is a reduced plan view.

Consists of a candle-socket A on the end of an axial rod B, of a float C, contained in a water-chamber D. The vertical motion of the float is retained at the top by the socket-rod passing through a guide-frame E, and at the bottom by an axial guide-rod F of the float and a guide-tube G, which forms a reduced extension of the chamber D. A candle H is placed in the socket A, and water is poured in the chamber D until the float C rises to the zero-point of the stationary



NEW PHOTOMETER.

scale I (graduated in grains), as shown by the index J fixed to the float. On the candle being lighted, its burning and consuming increase the specific lightness of the float, which gradually and imperceptibly rises in the water, and keeps the burning-point of the candle, without variation, at the same altitude. The index J, rising with the float, shows on the scale the candle consumed in grains. To preclude any possibility of the chamber D not having sufficient water capacity to float the index J to the zero-point of the scale, a dish or an enlargement K of the chamber D can be used to hold the additional supply of water.

SWINGING SHIP'S BERTH.

By E. P. S. ANDREWS, Lisbon, Me.

FIG. 1, vertical transverse section. Fig. 2, longitudinal section.

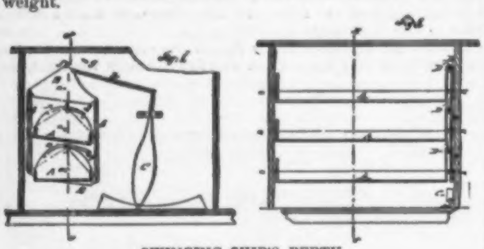
The object is to prevent sea-sickness.

Consists of one or more berths pivoted to the cabin-walls, and connected by separate and jointly-swinging governing end-plates, of which one is applied to a swinging weight of corresponding size, to produce the level position of the berths. A pivoted hook-lever of each berth may be attached to the corresponding end-piece, to swing therewith and with the weight, or to a staple of the wall, to assume a fixed position at the wall.

A, the berths, hung by central pivot-pins *a*, at the head and foot pieces, to the walls of the cabin. A separate governing piece or plate B is arranged at the head or foot piece of each berth, intermediately between the same and the wall, and hung to the same pivots *a*. The pieces B are connected at opposite sides by parallel pivot-rods *b*, to produce their joint motion following the movement of a governing weight C, connected to one of the plates by lever-rod *d*. The weight C is fulcrumed, and inclosed either in a casing or in the partition walls. It swings with the motion of the vessel, assuming a perpendicular position, and bringing thereby the berths continually to a level, so that a person will not feel

the influence of the rolling motion of the vessel, and be, therefore, protected against the attacks of sea sickness.

Each berth A is provided at its end piece, toward the swinging-plate B, with a pivoted hook-lever D, that is recessed to lock to a hook *f* of the swinging end plate, and cause thereby the following of the berth to the oscillation of the weight.



SWINGING SHIP'S BERTH.

The end of hook-lever D may, after being released from the end-plate, be hooked to a staple, eye, or other fixed device *g* of the cabin partition-wall, being thereby rigidly attached thereto, and compelled to follow the motions of the vessel. The other berths continue to adjust themselves by gravitation, each passenger being left free to use the berth in connection with the weight, as a protection against sea-sickness or not, as described.

[Nature.]

THE THEORY OF "STREAM LINES" IN RELATION TO THE RESISTANCE OF SHIPS.*

(Continued from p. 81.)

I HAVE pointed out that the causes of resistance to the motion of a ship through the water are: first, surface-friction; secondly, mutual friction of the particles of water (and this is only practically felt when there are features sufficiently abrupt to cause eddies); and, thirdly, wave-genesis. I have also shown that these are the *only* causes of resistance. I have shown that a submerged body, such as a fish, or torpedo, travelling in a perfect fluid, would experience no resistance at all; that in water it experiences practically no resistance but that due to surface-friction and the action of eddies; and that a ship at the surface experiences no resistance in addition to that due to these two causes, except that due to the waves she makes. I have done my best to make this clear: but there is an idea that there exists a kind of resistance, a something expressed by the term "direct head-resistance," which is independent of the above-mentioned causes. This idea is so largely prevalent, of such long standing, and at first sight so plausible, that I am anxious not to leave any misunderstanding on the point.

Lest, then, I should not have made my meaning sufficiently clear, I say distinctly, that the notion of head-resistance, in any ordinary sense of the word, or the notion of any opposing force due to the inertia of the water on the area of the ship's way, a force acting upon and measured by the area of midship section, is, from beginning to end, an entire delusion. No such force acts at all, or can act; as throughout the greater part of this address I have been endeavoring to explain. No doubt, if two ships are of precisely similar design, the area of midship section may be used as a measure of the resistance, because it *is* a measure of the size of the ship; and if the ships were similar in every respect, so also would the length of the bowsprit, or the height of the mast, be a measure of resistance, and for just the same reason. But it is an utter mistake to suppose that any part of a ship's resistance is a direct effect of the inertia of the water which has to be displaced from the area of the ship's way. Indirectly the inertia causes resistance to a ship at the surface, because the pressures due to it makes waves. But to a submerged body, or to the submerged portion of a ship travelling beneath rigid ice, no resistance whatever will be caused by the inertia of the water which is pushed aside. And this means that, if we compare two such submerged bodies, or two such submerged portions of ships travelling beneath the ice, as long as they are both of sufficiently easy shape not to cause eddies, the one which will make the least resistance is the one which has the least skin surface, though it have twice or thrice the area of midship section of the other.

The resistance of a ship, then, practically consists of three items—namely, surface-friction, eddy-resistance, and wave-resistance.

Of these the first-named is, at least in the case of large ships, much the largest item. In the Greyhound, a bluff ship of 1100 tons, only 170 feet long, and having a thick stem and sternposts, thus making considerable eddy-resistance, and at ten knots visibly making large waves, the surface-friction was 58 per cent of the whole resistance at that speed; and there can be no doubt that with the long iron ships now built, it must be a far greater proportion than that. Moreover the Greyhound was a coppered ship; and most of the work of our iron ships has to be done when they are rather foul, which necessarily increases the relative importance of the surface-friction item.

The second item of resistance, namely, the formation of eddies, is, I believe, imperceptible in ships as finely formed as most modern iron steamships. Thick square-shaped stems and stern-posts, more especially the latter, are the most fruitful source of this kind of resistance.

The third item is wave-resistance. To this alone of the three is the stream-line theory directly relevant, and here, as we have seen, it rather suggests tendencies than supplies quantitative results, because, though it indicates the nature of the forces in which the waves originate, the laws of such wave combinations are so very intricate, that they do not enable us to predict what waves will actually be formed under any given conditions.

There are, however, some rules, I will not call them principles, which have to some extent been confirmed by experiment. At a speed dependent on her length and form, a ship makes a very large wave-resistance. At a speed not much lower than this, the wave-resistance is considerably less, and at low speeds it is insignificant. Lengthening the entrance and run of a ship tends to decrease the wave-resistance; and it is better to have no parallel middle body, but to devote the entire length of the ship to the entrance and run, though in this case it be necessary to increase the midship section in order to get the same displacement in a given length.

With a ship thus formed, with fair water-lines from end to end, the speed at which wave-resistance is accumulating most rapidly is the speed of an ocean-wave the length of which, from crest to crest, is about that of the ship from end to end.

I have said we may practically dismiss the item of eddy-resistance. The problem, then, to be solved, in designing a ship of any given size, to go at a given speed with the least resistance, is to so form and proportion the ship that at the given speed the two main causes of resistance, namely, surface-friction and wave-resistance, when added together, may be a minimum.

In order to reduce wave-resistance we should make the ship very long. On the other hand, to reduce the surface-friction we should make her comparatively short, so as to diminish the area of wetted skin. Thus, as commonly happens in such problems, we are endeavoring to reconcile conflicting methods of improvement; and to work out the problem in any given case we require to know actual quantities. We have sufficient general data from which the skin-resistance can be determined by simple calculation; but the data for determining wave-resistance must be obtained by direct experiments upon different forms to ascertain its value for each form. Such experiments should be directed to determine the wave-resistance of all varieties of water-line, cross-section, and proportion of length, breadth, and depth, so as to give the comparative results of different forms as well as the absolute result for each.

An exhaustive series of such experiments could not be tried with full-sized ships; but I trust that the experiments I am now carrying out with models, for the Admiralty, are gradually accumulating the data required on this branch of the subject.

I wish, in conclusion, to insist again, with the greatest urgency, on the hopeless futility of any attempt to theorize on goodness of form in ships, except under the strong and entirely new light which the doctrine of stream-lines throws on it.

It is, I repeat, a simple fact that the whole frame-work of thought by which the search for improved forms is commonly directed, consists of ideas which, if the doctrine of stream-lines is true, are absolutely delusive and misleading. And real improvements are not seldom attributed to the guidance of those very ideas which I am characterizing as delusive, while in reality they are the fruit of painstaking, but incorrectly rationalized, experience.

I am but insisting on views which the highest mathematicians of the day have established irrefutably; and my work has been to appreciate and adapt these views when presented to me.*

No one is more alive than myself to the plausibility of the unsound views against which I am contending; but it is for the very reason that they are so plausible that it is necessary to protest against them so earnestly; and I hope that, in protesting thus, I shall not be regarded as dogmatic.

In truth, it is a protest of scepticism, not of dogmatism; for I do not profess to direct any one how to find his way straight to the form of least resistance. For the present we can but feel our way cautiously towards it by careful trials, using only the improved ideas which the stream-line theory supplies, as safeguards against attributing this or that result to irrelevant or, rather, non-existing causes.

IV.

SUPPLEMENTARY NOTES.—A.

THE proposition, that the flow of fluid through a tortuous pipe when its ends are in the same straight line, does not tend to push the pipe endways, can be treated in several ways, of which only one is given in the text of the address; but it may be interesting to some readers to trace some of the others ways of viewing the question.

First let us take the case of a right-angled bend in a pipe (that is to say where the direction of a pipe is altered through a right angle by a curve of greater or less radius; a bend of this sort is shown in Fig. 29), and assume that the fluid in it at A is flowing from A towards C. I propose at present to

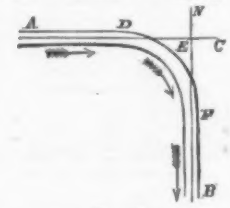


FIG. 29.

deal only with those forces or tendencies which act more or less powerfully in the direction of the original motion of the fluid—namely, along the line AC.

I must here remind you that I am dealing with this matter entirely independently of hydrostatic pressure. Perhaps to some it will be difficult to dissociate the idea of hydrostatic pressure from a fluid in a pipe. This difficulty might be got over by assuming that the pipe is immersed in a fluid of the same density and head as the fluid within it. There will thus be hydrostatic equilibrium between the fluid within and without the pipe, the only difference being that the fluid inside the pipe is assumed to be in rapid motion, and thus to subject the pipe independently to any stresses properly incidental to that motion of the fluid within it.

The sole work that has to be done in the present case, is that of deflecting the current of fluid to a course at right angles to its original course AC; and, regarding these forces as resolvable throughout into two sets of components, the one at right angles to the line AC, the other parallel to it, it is of the latter alone that account is to be taken. Manifestly the sum of these components is measured by the circumstance that it is precisely sufficient to entirely destroy the forward momentum of the fluid that flows along the pipe at A towards the bend. This force is administered to the fluid by the curved portion of the pipe at the bend DEF; and as the pipe is assumed to be rigid, the work of arresting the forward velocity of the fluid throws a forward stress on the pipe in a direction parallel to the line AC.

Let us now assume that to the right-angled bend AB we attach rigidly a second right-angled bend, BG, as shown in Fig. 30, in such a manner that the termination of this second bend at G is parallel to the commencement of the first bend at A. Here I will again, for the present, deal only with the forces in a direction parallel to the line AC.

The fluid at B has no velocity in the direction of the line AC, and at G it has a velocity in that direction equal to the velocity which it had at A. To give it this velocity in a for-

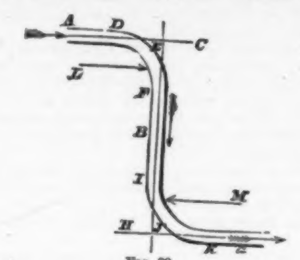


FIG. 30.

ward direction (I mean forward in its original direction of motion), to establish this forward momentum, requires the application of a force in the direction HG; and this force is administered to the fluid by the curved portion of the pipe at the bend IJK; and as the pipe is assumed to be rigid, the duty of establishing the forward velocity of the fluid throws a rearward stress on the pipe in the direction GH. Now as the forward momentum given to the fluid between B and G in the line GH is exactly the same as the momentum destroyed between A and B in the line AC, it follows that the rearward stress thrown on the pipe at the bend IJK is exactly equal to the forward stress thrown on the pipe at the bend DEF. Hence it will be seen that the forces acting on the rigid pipe AG, treated as a whole, balance, so far as relates to the forces parallel to the line AC, the original line of motion of the fluid—the forward stress acting on the pipe at the bend DEF being balanced by the equal rearward stress acting on the pipe at the bend IJK. These two of the forces acting on the pipe are shown by the arrows L and M, which, it must be remembered, are the only forces which act in a direction parallel to the line AC.

It will have been seen that the measure of these forces is the amount of forward momentum of the fluid which is destroyed or created; and from this it will be inferred that the forces will be the same, no matter what is the radius of the curve of the pipe, inasmuch as the curvature of the pipe does not affect the amount of the forward momentum that has to be destroyed or replaced in the fluid.

Let us next take the case of a bend in a pipe that is not a right angle, as shown in Fig. 31; and here, as before, I only

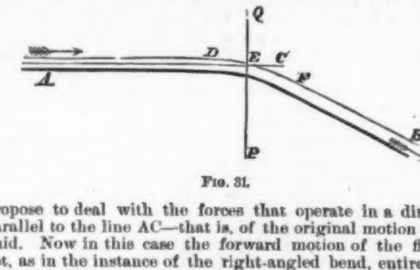


FIG. 31.

propose to deal with the forces that operate in a direction parallel to the line AC—that is, of the original motion of the fluid. Now in this case the forward motion of the fluid is not, as in the instance of the right-angled bend, entirely destroyed in its progress from A to A; only a portion of the forward motion is checked, and the same portion of the forward momentum destroyed; and the force by which it is destroyed is administered to the fluid by the curved portion of the pipe at the bend DEF, and, as in the former case, constitutes a forward stress on the pipe in the direction of the line AC, which will bear the same ratio to the stress which would follow from the destruction of the whole, as the portion destroyed bears to the whole forward momentum.

Suppose to this bend we attach rigidly another bend BG, of same angle, as shown in Fig. 32, so that the termination of this second bend at G is parallel to the commencement of the

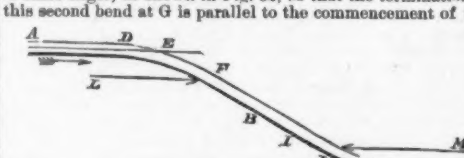


FIG. 32.

first bend at A. Here, in the portion of the pipe BG, that part of the forward velocity which was taken away has to be again given to the fluid; this requires force, which is administered to the fluid by the curved part IJK of the pipe.

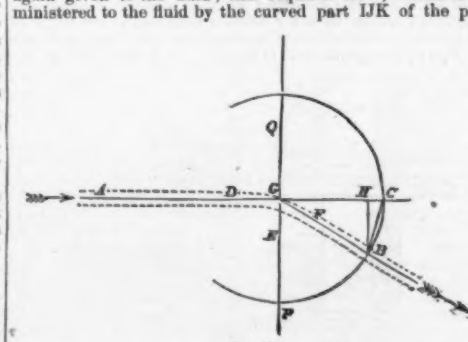


FIG. 33.

Let AGB = angle of bend.

Let GC = force required to destroy the whole momentum of fluid in line AC.

" = tension which would be put on pipe AD by a right-angled bend.

Then HC = force required to destroy momentum lost at the bend in the line AC.

And H B = force required to establish momentum acquired at bend in line QP.

∴ BC = total force acting on pipe.

This force must be in equilibrium with the tensions of pipe along BG and AC.

∴ the tension of pipe = GC or GB.

i. e, = the tension of pipe when the bend is right angled.

Therefore the tension of the bent pipe is constant for a given velocity of flow, whatever be the angle of the bend.

There is thus thrown on the pipe a rearward stress represented by M. The force required in the bend between B and G to reinstate completely the forward velocity, is evidently the

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* Address to the Mechanical Section of the British Association, Bristol, August 25, 1875, by William Froude, C.E., M.A., F.R.S., President of the Section. Revised and extended by the author.

* I can not pretend to frame a list of the many eminent mathematicians who originated or perfected the stream-line theory; but I must name, from amongst them, Prof. Rankine, Sir William Thomson, and Prof. Stokes, in order to express my personal indebtedness to them for information and explanations, to which chiefly (however imperfectly utilized) I owe such elementary knowledge of the subject as alone I possess.

same in amount as the force required in the bend between A and B to destroy in part the forward velocity.

It follows, therefore, that the two stresses on the pipe, represented by the arrows L and M, which indicate the forces acting on the pipe, are equal and opposite to one another, and these are the only forces acting on the rigid pipe in a direction parallel to the line AC or the original motion of the fluid at A. It follows, therefore, that in case of two right-angled bends rigidly connected, or in the case of two connected equal-angled bends of any other angle, the stresses brought on the pipe by the flow of the fluid will not tend to move the pipe bodily endways.

It will be seen also by this reasoning that the forces we have referred to do not depend on the curvature of the pipes, but are simply measured by the amount of the forward momentum of the fluid and the extent to which that momentum is modified by the total of the deflection which the course of the fluid experiences in passing the bend, or, in other words, by the angle of the bend. And from this reasoning it becomes apparent that by whatever bends or combinations of bends we divert the course of a stream of fluid in a pipe, provided the combination be such as to restore the stream to its original direction, the aggregate of the forces in one direction required to destroy forward momentum are necessarily balanced by equal forces in the opposite direction required to reinstate the former momentum.

It will be useful to consider more in detail the action of all the forces operating on a fluid in a bend of the pipe; and I will return to the case of a single right-angled bend, as shown in Fig. 29. I before spoke merely of the forces acting parallel to the line AC, and said that the forward momentum of the fluid in that line had to be destroyed in its passage round the bend DEF, and that this must be effected by a force acting parallel to AC, which would throw a forward stress on the pipe, tending to force it in the direction AC. But similarly velocity has to be given to the fluid in the direction NB; and to do this a force must be administered to the fluid which will cause a reaction on the pipe in the direction BN; and as the momentum to be established in the direction NB has to be equal to that in the direction AC, which had to be destroyed, it follows that the forces of reaction upon the pipe in the directions AC and BN are equal. These forces can be met in two ways, either by securing the bent part of the pipe DEF so that it will in each part resist the stresses that come on it, or by letting the forces be resisted by the tensional strength of the straight parts of the pipe AD and BF operating in the direction of their length; and in this case we see that the tension on AD must be equal to the force acting along AC, and the tension on BF must be equal to the force acting along BN, so that in fact the forces brought into

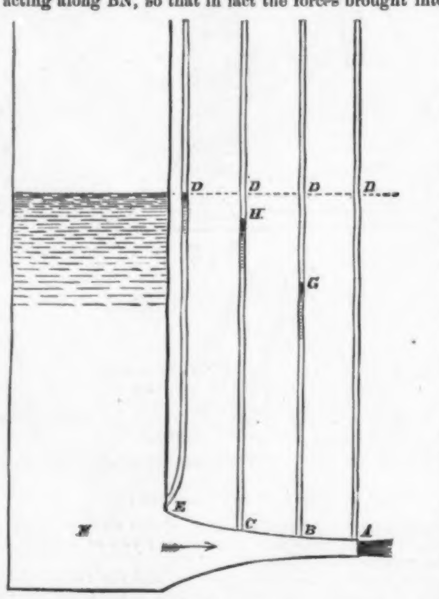


FIG 34.

play by the right-angled bend produce a longitudinal tension on the pipe at either end of the bend equal to the force required to destroy the forward momentum of the fluid.

Proceeding to the case of the non-right-angled bend as shown in Fig. 31: in this case, as we have seen, a portion only of the forward momentum of the fluid in the line AC has to be destroyed, also a certain amount of sideways momentum has to be created in a direction which we may consider parallel to the line QP; and the composition of the remaining forward momentum in the line AC with the created sideways momentum in the line QP, results in the progress of the fluid along the path FB; this partial destruction of forward momentum and establishment of some sideways momentum are essential to the onward progress of the fluid along FB. The bend DEF will be subject to the reaction of the forces necessary to produce these changes; and either the bend may be locally secured, or the stress upon it may be met, as in the case of the right-angled bend we have just been considering, by a tensional drag on the pipe at either end of the bend. There is, however, this difference between the cases, that the force required to establish sideways momentum parallel to QP can not be directly met by the reaction of tension along the line BF of the second part of the pipe; but this force may be met by the obliquely acting tension of the pipe BF combined with the induced tension along the pipe AD. It is well known that in the case of a given force, such as that we are supposing parallel to PQ, resisted by two obliquely placed forces such as the tension along the lines DA and FB, the nearer the lines DA and FB are to one straight line, the greater must be the tension along those lines to balance a given force acting on the line PQ. Now the less the line FB diverges from the line AC, the less will be the sideways momentum parallel to QP that has to be imparted to the fluid; but at the same time and to precisely the same extent will the proportionate tension put upon the limbs DA and FB of the pipe be aggravated by the greater obliquity of their action. The sideways pull is greatest when the bend is a right angle; and then it amounts to a force that will take up or give out the entire momentum of the fluid, and it is supplied directly by the tension of the limb of the pipe at FB. If the bend is made less than a right angle, the less the bend is made, the less is the sideways pull, but the greater by the same degree is the disadvantage of the angle at which the tension on the pipe resists the pull; and it results from this that in the case of a bend other than a right angle, the tension on the pipe is the same as in the case of a right-angled bend. A geometrical proof of this is given in Fig. 33. It is evident that the radius of curvature of the bend does not enter into this consideration, and that the forces acting are not affected by the rate of curvature of the pipe, the simple measure of the forces being the increase or decrease in the momentum of the fluid in each direction. It results from this that if a fluid be flowing along a pipe with a bend in it, no matter what may be the angle of the bend, or the radius of its curvature, the reactions necessary to deflect the path of the fluid will be met by a tensional resistance along the pipe; and this tension is equal to the force that would be required to entirely destroy the momentum of the fluid.

If we now assume any number of bends, of any angle or curvature, to be connected together (see Fig. 3), the equilibrium of each bend is satisfied by a longitudinal tension which is in every case the same; and this tension is therefore uniform throughout the pipe; for the tension at any intermediate point in a bend is clearly the same as at the ends of the bend, as we may suppose the bend divided at that point into two bends, and there joined together by an infinitely short piece of straight pipe.

If, then, the tortuous pipe I have above referred to has its ends at A and B parallel to one another, as shown in Fig. 4, it is clear that the tensional forces at its ends balance one another, and the pipe, as a whole, does not tend to move endways.

NOTE B.

The law regulating these changes of pressure due to changes of velocity can be best understood by considering the case of a stream of perfect fluid flowing from a very gradually tapered pipe or nozzle placed horizontally and connected with the bottom of a cistern, as shown in Fig. 34. Let us suppose that at the points B and C the sectional areas of the pipe are severally twice and four times that at the point of exit A.

At the point of exit A the fluid is under no pressure whatever, since there is no reacting force to maintain any pressure; each particle of fluid in the issuing jet is rushing forward on its own account, neither giving nor receiving pressure from its neighbors. We know, however, what force it has taken to give the velocity which the fluid has at the point of issue A, and we measure this force by the pressure or head of fluid lost. In the case we are considering, this head is represented by the height of the fluid in the cistern, or by the height AD.

Within the cistern, at the point E, on the same level as A, the point of issue—at this point E within the cistern, we have in effect the whole pressure due to the head of fluid equal to AD, but we have no velocity—at any rate, the velocity is so small as to be inappreciable; and at the point of issue A we have no pressure at all, but we have what is termed the "velocity due to the head."

Let us suppose that at the points A, B, C, and E, gauge-glasses or stand pipes are attached so that the fluid in each may rise to a height corresponding with the pressure within the pipe or nozzle at the point of attachment.

The gauge-glass attached at A will show no pressure, thus indicating that the entire head AD has been expended in producing the velocity at the point A.

At the point B, as the sectional area is twice, the velocity is one half that at A. Now the head required to produce velocity varies as the square of the velocity to be produced; in other words, to produce half the velocity requires one quarter of the head; thus of the whole head AD available, one quarter only, or GD, has been absorbed in developing the velocity at B, and the remainder of the pressure, which will be represented by the head BG, will be sensible at the point B, and will be exhibited in the gauge-glass attached at that point.

Again, as the pipe at C is four times the area that it is at A, it follows that, of the whole head AD, one sixteenth part only, or HD, has been absorbed in developing the velocity at C, and the remainder of the pressure, which will be represented by the head CH, will be sensible at the point C, and will be exhibited in the gauge-glass attached at that point.

In the case I have chosen for illustration, the small end, A, of the nozzle, is open and discharging freely, and the pressure at that point is therefore *nil*. But the absolute differences of pressure at each point of the pipe or nozzle will be precisely the same (as long as the same quantity of fluid is flowing through it per second), however great be the absolute pressures throughout.

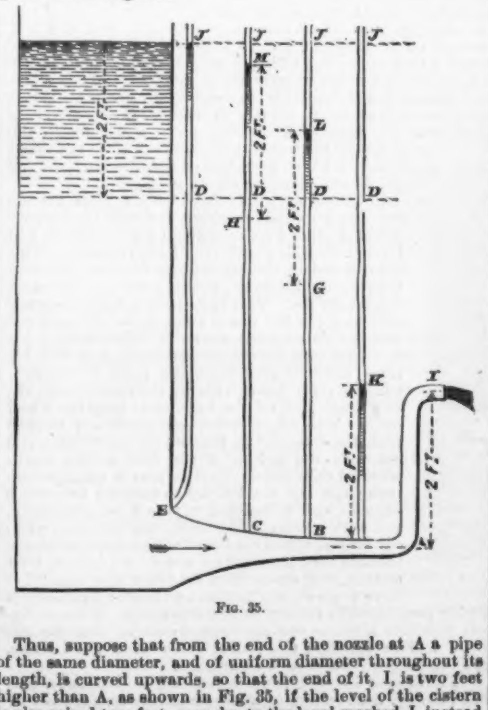


FIG. 35.

Thus, suppose that from the end of the nozzle at A a pipe of the same diameter, and of uniform diameter throughout its length, is curved upwards, so that the end of it, I, is two feet higher than A, as shown in Fig. 35, if the level of the cistern is also raised two feet, namely, to the level marked I, instead of D, we shall have the same delivery of fluid as before; and the differences between the pressures at each point will be the same as before.

If we add 50 feet instead of 2 feet to the head in the cistern, and raise I to 50 feet, instead of 2 feet above the nozzle, the differences of head or pressure will still be the same, the head at A being 50 feet, that at B being BG + 50 feet, that at C, CH × 50 feet, and that at E (the cistern-level) ED × 50 feet.

To put the case into actual figures, suppose the sectional area at A to be 1 square inch, that at B 2 square inches, and that at C 4 square inches, and suppose that the fluid is passing through the nozzle at the rate of one ninth of a cubic foot per second, we shall have a velocity at A of 16 feet per second, to generate which would require a difference of pressure between E and A, equivalent to 4 feet of vertical head. The velocity at B will be 8 feet per second, which would require a difference between E and B equivalent to 1 foot of head. That at C will be 4 feet per second, and will require a difference of pressure equivalent to 3 inches of head. If the pressure at A be zero, the pressures at B, C, and E will be 3 feet, 3 feet 9 inches, and 4 feet respectively. If the pressure at A be 1 foot, the pressures at B, C, and E will be 4 feet, 4 feet 9 inches, and 5 feet respectively; and if the pressure at A be 1000 feet, the pressures at B, C, and E will be 1003 feet, 1003 feet 9 inches, and 1004 feet respectively, always supposing the quantity of fluid passing per second to be the same. If the quantity be different, the absolute differences of pressure will be different, but will be relatively the same. If, for instance, the quantity flowing per second be doubled, the velocity at each point will be doubled, and the differences of pressure quadrupled; so that if the pressure at A were again 1000 feet, those at B, C, and E would be 1012 feet, 1015, and 1016 feet respectively.

To sum up—the differences of hydrostatic pressure at different points vary as *the differences of the squares of the velocities* at those points.

NOTE C.

Here again the argument given in the text suggests certain other lines of argument which some persons may feel interested in following out.

Suppose each and every one of the streams into which we have subdivided the ocean, to be inclosed in an imaginary rigid pipe made exactly to fit it, throughout, the skin of each pipe having no thickness whatever. The innermost skin of the innermost layer of pipes (I mean that layer which is in contact with the side of the body), the innermost skin, I say, of this layer is practically neither more nor less than the skin or surface of the body. The other parts of the skins of this layer, and all the skins of all the other pipes, simply separate fluid from fluid, which fluid, *ex hypothesi*, would be flowing exactly as it does flow if the skins of the pipes were not there; so that, in fact, if the skins were perforated, the fluid would nowhere tend to flow through the holes. Under these circumstances there clearly can not be any force brought to bear in any direction by the flow of the fluid, on any of the skins of any of the pipes except the innermost skin of the innermost layer. Now, remembering that we are dealing with a perfect fluid which causes no surface-friction, we know that the fluid flowing through this system of pipes administers no total endways force to it. But it produces, as we have just seen, no force whatever upon any of the skins which separate fluid from fluid; consequently, if these are removed altogether, the force administered to the remainder of the system will be the same as is administered to the whole system—namely, no total endways force whatever. But what is the remainder of the system? Simply the surface of the body, which is formed, as I have already said, by the innermost skins of the innermost layer of pipes. Therefore no total endways force is administered to the surface of the body by the flow of the fluid.

Lastly, let us recur for an instant to the case of fluid flowing through the single flexible pipe. Here it was proved that the flow of the fluid through it, if it was anchored at the two ends, did not tend to displace any part of it, because the centrifugal forces produced by the flow of the fluid, and which must act exactly at right angles, or normally, as it is called, to the line of pipe at each point, are exactly counterbalanced by a uniform tension throughout the length of the pipe. If the flexible pipe has variations in its diameter, the differences of quasi-hydrostatic head appropriate to those variations are also normal to the surfaces of the pipe, being simply bursting-pressures. If, however, these normal forces were directly counterbalanced by equal and opposite and normal external forces or supports, it is obvious that this tension would be entirely relieved. Now, if we suppose the system of pipes which we have several times already imagined to surround the submerged body, to be flexible pipes (instead of rigid pipes, as we have before imagined them), the counterbalancing, or normal, external forces which exactly relieve the tension are supplied to each pipe by its neighbor, except in the case of the innermost skin of the innermost layer of pipes, since this innermost skin has no neighbor. In this instance the counterbalancing, normal, external forces are supplied by the rigidity of the surface of the body. Now we know that, since the tensional forces produced by the flow of fluid through a flexible pipe, whether of uniform or varying sectional area, have no sum total of endways force, the counterbalancing forces which exactly relieve this tension must also have no total endways force; and since the counterbalancing forces acting throughout the whole system have thus no sum total of endways force, it can be proved, as before in the case of the similar system of rigid pipes, that if we remove the whole of the skins or sides of pipes, which separate fluid from fluid, and which are all therefore necessarily in perfect equilibrium, the forces acting on the remainder, namely, on those skins which are in contact with the surface of the body, forces which therefore may be considered as acting simply upon the body, must also have no endways sum total.

TELEGRAPH STATIONS IN MID-OCEAN.

THE discussion of the practicability of establishing telegraph stations in mid-ocean, by which messages can be sent from any part of the sea along the line of the cable to the terminal points on shore, and *vice versa*, so that communication with iron-clads, mail steamers, and other vessels when out at sea, may be established, has been revived. A new invention consists of a hollow sectional column, with a base plate attached by ball and socket joint, which column is lowered into the water and anchored rigidly to the ground. The branch cable is coupled to the main cable, and carried along the column to the surface of the water, to be there connected with instruments on board the vessels. By this invention it is proposed to control naval and strategical movements, while a ship in distress could communicate her exact position, the nature of her disasters, and thus procure assistance.—*London Standard*.

A FAST VELOCIPEDE.

Professor George Grant, of New-Glasgow, Nova Scotia, is the author of the singular-looking vehicle shown in our sketch. Queer as it looks, it contains the elements of speed. The large driving-wheel is operated by crank-pulleys, as shown, the steering being done by the passenger's feet. The author states that on smooth ice he has attained a velocity of a mile per minute. On hard smooth roads the vehicle runs with ease, while as to the steerage, it is under perfect control. The device has the merit of simplicity.

A FAST VELOCIPEDE.

EDINBURGH TRICYCLE.

A correspondent of the *Field* says: "My tricycle weighs 83 lbs., and, when loaded for a summer journey of several days, it is made to carry myself, 196 lbs., and an overcoat, spare clothes, a book, sketch-book, colors, etc., to the extent in all of 221 lbs. I have always a comfortable seat to sketch from, or to rest in when I need, with great ease in driving. You may think it hard to move such a weight as I have mentioned. Given a good road, it is not so, even up a moderate slope. The two wheels in front are acted on by the steering-gear; the driving-wheel behind, the 9-inch cranks being connected by rods with treadles in front. For easier stowage in a railway-car I have my driving-wheel of 36 inches only; therefore the speed is but low. Although I can put it along on level ground at the rate of eight or nine miles an hour, I seldom cover more than six in travelling; but the road must be very bad to reduce me to four."

EDINBURGH TRICYCLE.

AQUATIC VELOCIPEDE.

M. Jobert has produced a new nautical velocipede, the structure of which is ingenious, and yields satisfactory results. The apparatus is composed of two cylinder floats of white sheet-iron, pointed at the extremities. These are bound together by a platform of light wood, on which is the seat of the conductor, and the mechanism by which the velocipede is set in motion on the surface of the water. This mechanism consists of a paddle-wheel, the axis of which is furnished with stirrups on which rest the feet of the conductor. The movement which the *velocipedist* executes to work the nautical velocipede is similar to that which the terrestrial velocipede necessitates; the two feet rise and descend alternatively, giving a movement of rotation to the wheel. In order to produce a deviation to the right or left of the straight line, a small rudder is arranged at the back of the apparatus, which is moved by two cords attached to the handles under the conductor's hands.—*La Nature.*

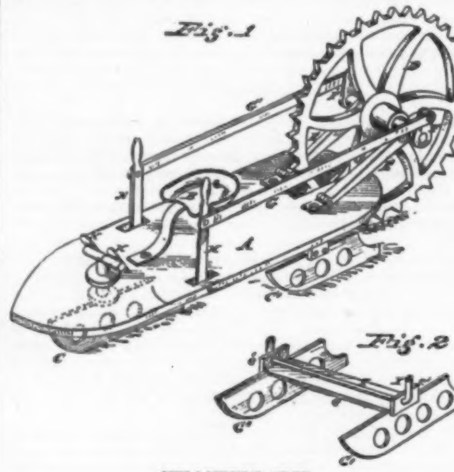
AQUATIC VELOCIPEDE.

VELOCIPEDE SLED.

By J. M. Story, Cincinnati, O.

Consists in certain peculiar appliances, by which the rider is enabled to propel the sled, the appliances being so arranged that the propelling-wheel will ride over undulating surfaces without affecting the bearing of the runners upon the ice.

D, the propelling-wheel armed with projecting teeth *d*, to firmly engage in the face of the ice or snow. This wheel is journalled in swinging arms E E, hinged at *e* to the body A, and its shaft is fitted at both ends with cranks F F′, to which connecting rods G G′ are attached, the other ends of the latter being connected by a swiveling-joint with the hand-levers H H′. By this provision of the swiveling or swinging arms E E′, in connection with the propelling-wheel and its driving attachments, the wheel is enabled to ride over uneven surfaces, while the runners are also permitted to run over uneven surfaces without either the wheel or runners being deprived of its bearing on the surface of the ice or snow. The hind runners C′ C″ are secured together by cross-bar *c*, and have ears *c′* to fit over the bar or bail I, which is secured to the body A. This construction enables the runners to automatically adjust themselves to undulating surfaces. The foreward runner C is made, as shown, to swivel in the body A for steering purposes, and is provided with cross-bar J and foot-rests K, by which the operator is enabled to change the direction of this runner at will.



VELOCIPEDE SLED.

BICYCLE-RIDING.

This is a sport confined to a select few in this country; but in England it is extensively practised, with great satisfaction by the riders. Some of them give their experience in the *English Mechanic* as follows. L. Striffler, Secretary of Zephyr Bicycle Club, Moston, says: "I have had a roadster made to order, with a 51-inch driver, and it only weighs 30 lbs., and is plenty strong enough. I have discarded the brake as a nuisance, a danger, and extra weight. The best brake is your feet on the pedals, holding back; and if the hill is so steep that it overcomes you, then you may depend it is not safe to ride down, but get off and walk. Always lean well back when descending a hill, and incline forward when ascending, or when riding against a head wind. When riding on a tolerably level road, and especially if going fast, keep upright and firm in your saddle, and you will have no fear of a spill if you happen to come against a stone. Of course, the use of the step is an absolute necessity with our present sized machines, as far as mounting is concerned. I prefer vaulting off from the treadle, as it saves feeling about with your foot for the step, and perhaps catching your toe in the front wheel spoke. If you are riding through a town, if the same be paved and wet, be very careful about turning, as the mud which accumulates in towns seems to acquire a greasy consistence, and seems to completely lubricate the road; and if you turn sharply, your wheel runs away sideways, and you find yourself on the ground. I think it is wise to walk through towns if they are paved, and especially if wet, as you can not get any speed, and it is no comfort to yourself, and the incessant jolting has a tendency to loosen your spokes. When going through a country town with macadamized roads, it is glorious to slip through at railway speed and astonish the natives; but whenever I come to a piece of ground which is paved with sets or rubble-stones, let me get off and take pity on my good steed."

B. Travis says: "I have been a rider for six years on a wooden machine, and now on a spider-wheeled one. I am only about 5 feet 2 inches, and I ride a 45-inch wheel, with 5-inch cranks. With it I can and do ride up inclines much easier than with my old machine; yet they are each the same weight (50 lbs.) This I attribute to the rider being able to apply his power because he sits over the wheel. Every rider who sits much behind his driving-wheel knows that in driving up hill his arms have to counteract the push of his feet, whereas push downwards on the treadle requires very little pull on the handles to keep the wheel right. The large wheel machines are worked with the fore part of the foot on the treadle, and not with the hollow of the foot, as the small-wheeled ones were. That is also a great advantage; the leg not having to traverse so great a distance, one is enabled to ride more gracefully, and with greater ease. Some machines are without brakes, the necessity of which depends on the inclines they have to run down. I live in a hilly district, and often on a Saturday afternoon trip I have to go over hills 1000 feet high. I consider it highly dangerous to attempt a run down some of them, unless you have a brake you can depend on, and then the run down will be splendid and swift; yet with a good brake, you can keep the machine well in hand.

"I have seen in your paper something said about a one-line railway, the running of a bicycle having inspired the remarks. Now, there is no analogy in the matter, for an engine or train would not keep erect on one line of rails only, unless it was perfectly balanced, and remained so. A man could not run a bicycle even under those conditions. It requires a continual side movement of the front wheel to restore the balance that is always being lost; for if the wheels were put in a straight line, and fastened, there is no rider could ride it, for he would quickly lose his equilibrium—he could not restore it, and down he must come.

"I have also seen remarks and suggestions about multiplying wheels, so that one turn of the crank will make two turns or more of the wheel. Now, it won't do. The same effect can be got by shortening the crank; but then, who has the strong legs required to drive them? Bicycles as made at present are very good, and very simple also; any addition of gearing will only impair them. Now, I do not expect that any rider will be able to propel himself through the air on any bicycle much over a mile in three minutes—for that is 20 miles an hour—the air itself being the great retarder. I would rather face an incline than a strong wind, it being impossible to go with any speed in face of a stiff breeze."

HAY-RICKING APPARATUS.

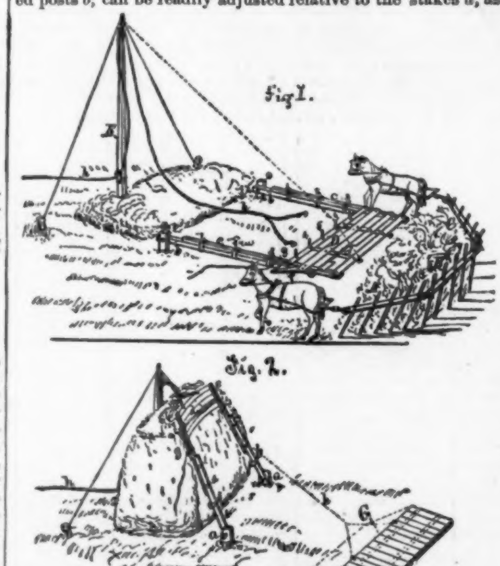
By J. R. Hill, Bloomfield, Iowa.

Figure 1 is a perspective view, illustrating the construction of rake and platform, and the manner of operating them. Fig. 2 illustrating the manner of elevating the hay, forming and roofing a rick. The hay is brought upon the platform D by the horses passing along the outside of the platform D, and dragging the rake A B C and its load upon the platform. The horses are then wheeled about to move away from the platform, and to withdraw the rake from its load deposited upon the platform. The long end of the lever *f* is then pressed in to engage the hook *g* and draw upon the rod *d*, and thereby spring the flexible platform D upward in its centre. The rope *h* is then attached to the platform, and a horse hitched at its free end to draw upon the rope and elevate the platform and its load, as represented in Fig. 2.

By pulling on the cord attached to the hook *g* the lever *f* is freed, and the bent bars of the platform D will spring back to their normal position, and thereby disengage and drop the load.

The platform D, carried by the bars *c* sliding on the hinged posts *b*, can be readily adjusted relative to the stakes *a*, as required by the gradual elevation of the stack or rick. The hinged flexible rake may be formed of two or more sections, and vary in size as desired.

The length of the posts *b*, bars *c*, and the size of the platform D may also vary to suit the size of the ricks and stacks desired.



HAY-RICKING APPARATUS.

[San Francisco Call.]

CHINESE ACROBATS.

The Chinese tumblers lately introduced into the Jackson Street Chinese Academy of Music are indeed marvels in their line. A number of athletic Mongolians appear stripped to the waist, and begin a sort of combat on the stage. At first the fighting appears to be promiscuous, but six or eight finally ally themselves against one man, and try to overcome him by springing against him and striking him full in the breast with the soles of their feet. He meets this curious mode of attack by standing like a statue, while the others fall heavily upon the floor. A number of tables are next brought out and piled one above the other until a height of about twenty feet is attained. A performer, whose weight is no less than 150 pounds, mounts them, and springing in the air toward the floor and the stage, strikes both feet with a heavy thud upon the bare breast of a man standing about ten feet from the foot of the tables, throwing him violently to the floor. How a man can sustain such a blow is a mystery.

Again the agile acrobat ascends to the top table, and, springing upward, turns a somersault, while all the tables except the lower one are suddenly taken away. Upon the only table left he falls with a force apparently great enough to break every bone in his body; but he leaps up again immediately and turns back handsprings across the stage. Again he climbs to the top of the tower of tables, while a second lies down upon a table a few feet from the base of the tower. Turning a somersault in mid-air he falls upon the other body, the two breast to breast, and bounds off again with a second somersault. Other acrobats climbed to various altitudes and fell upon the stage, alighting square upon their backs with a force that was astonishing. These feats were all executed by men in a semi-nude condition, so that there is no chance for padding their clothes. While the Americans in the theatre applaud, the Chinese make no demonstrations of approval, but look stolidly on.

The manager informed the *Call* reporter that the tumblers are trained from childhood, and become habituated to the terrible concussions only by years of practice. He added that many are killed in training, or maimed for life. None of their feats are graceful, but simply indicating a tremendous amount of nerve and endurance.